HUNGRY HORSE POWERPLANT ENLARGEMENT AND REREGULATING RESERVOIR

HUNGRY HORSE PROJECT, MONTANA

FORMULATION WORKING DOCUMENT

WATER AND POWER RESOURCES SERVICE
PACIFIC NORTHWEST REGION
BOISE, IDAHO

FEBRUARY 1981

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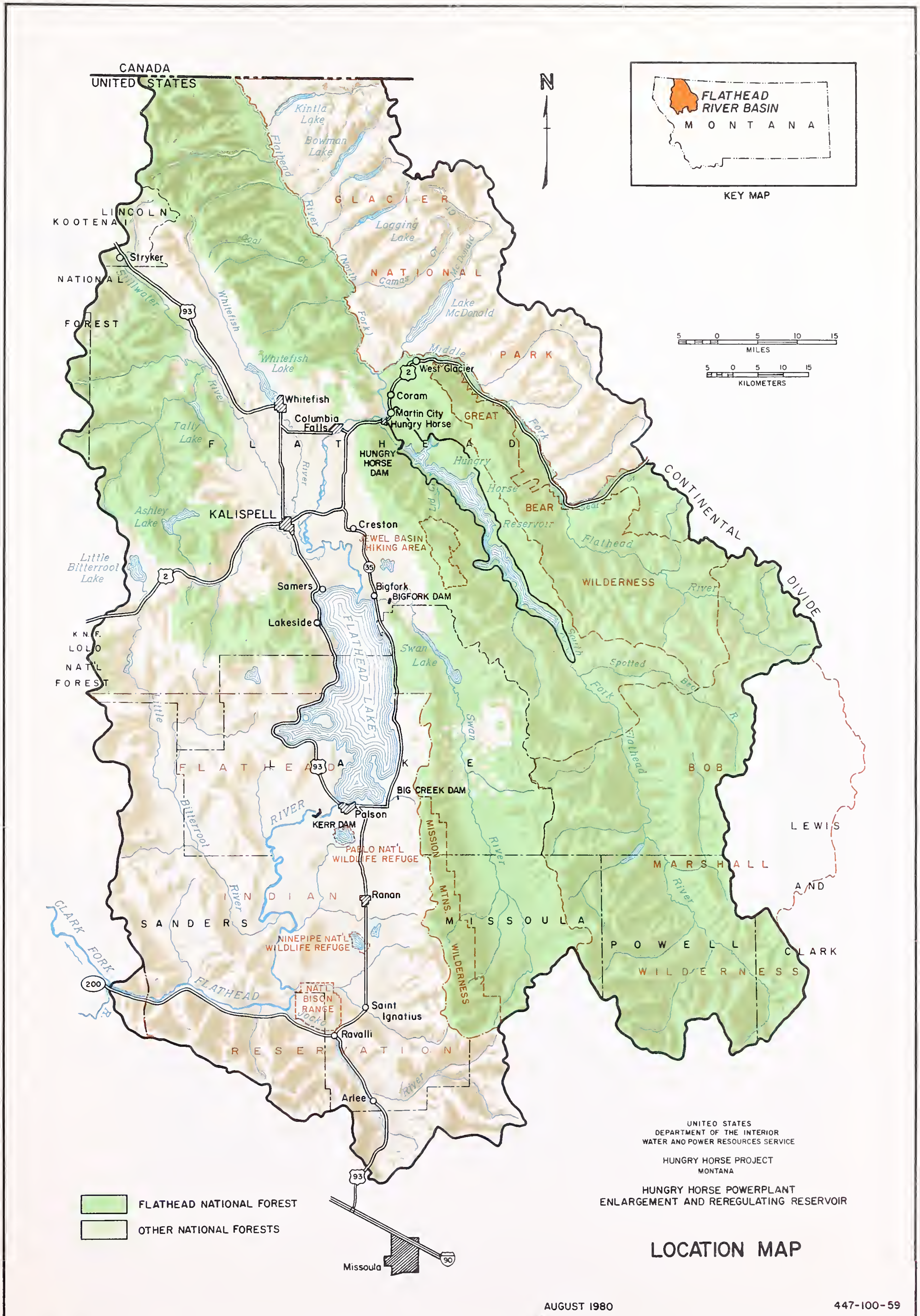
CANADA
UNITED STATES
KEY MAP
FLATHEAD RIVER BASIN
MONTANA
MILES
KILOMETERS
Kintla Lake
Bowman Lake
Logging Lake
Lake McDonald
Flathead River (North Fork)
GLACIER NATIONAL PARK
LINCOLN
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FOREST
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Whitefish Lake
Whitefish
Columbia Falls
Tally Lake
West Glacier
Coram
Martin City
Hungry Horse
HUNGRY HORSE DAM
Hungry Horse Reservoir
GREAT BEAR WILDERNESS
FLATHEAD
KALISPELL
Ashley Lake
Little Bitterroot Lake
Creston
JEWEL BASIN HIKING AREA
Somers
Bigfork
BIGFORK DAM
Lakeside
FLATHEAD LAKE
Swan Lake
CONTINENTAL DIVIDE
K.N.F.
LOLO
NAT'L
FOREST
BIG CREEK DAM
Polson
KERR DAM
PABLO NAT'L WILDLIFE REFUGE
MISSION MTNS. WILDERNESS
BOB MARSHALL WILDERNESS
LEWIS AND CLARK
MISSOULA
Ronan
SANDERS
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NINEPIPE NAT'L WILDLIFE REFUGE
CLARK FORK
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200
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FLATHEAD NATIONAL FOREST
OTHER NATIONAL FORESTS
UNITED STATES
DEPARTMENT OF THE INTERIOR
WATER AND POWER RESOURCES SERVICE
HUNGRY HORSE PROJECT
MONTANA
HUNGRY HORSE POWERPLANT
ENLARGEMENT AND REREGULATING RESERVOIR
LOCATION MAP
AUGUST 1980
447-100-59

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SUMMARY

This working document presents the findings of a preliminary investigation of the undeveloped power potential at the existing Hungry Horse Dam and Reservoir. The preliminary study has been done under the authority of Federal Reclamation Law (Act of June 17, 1902, 32 Stat. 388, and acts amendatory thereof and supplementary thereto). The Montana Department of Fish, Wildlife, and Parks and the U.S. Fish and Wildlife Service worked closely with the Water and Power Resources Service study team throughout the study and assisted in formulation and evaluation.

Hungry Horse Dam and Reservoir are located on the South Fork Flathead River in northwest Montana. The reservoir, with an active capacity of 2,982,000 acre-feet, is the farthest upstream and the third largest reservoir in the Federal Columbia River Power System. As such, the Hungry Horse Project provides important flood control operations and storage for downstream hydropower generation as well as onsite power generation. Present installed capacity at the powerplant is 285,000 kilowatts.

The Flathead River basin is a highly dissected mountainous area that contains a wide and relatively flat valley (Flathead Valley). Most of the basin is publicly owned and most of the area is forested. Of the upper Flathead River basin (Flathead County), approximately 80 percent is in public ownership and 90 percent is forested. Much of the basin is included in the national wilderness or national parks systems, and most of the Flathead River above the South Fork confluence is included in the National Wild and Scenic Rivers system.

The relatively pristine nature of the area is illustrated by the presence of several threatened or endangered species. These include the gray wolf, grizzly bear, bald eagle, and peregrine falcon. Big game species include deer, elk, and moose. Other wildlife includes migratory waterfowl, fur bearing animals, and nongame species.

The fishery of the Flathead River-Lake system is nationally renown. Although the system includes perch, bass, whitefish, and several species of trout, the kokanee fishery is the most important. Most of the kokanee spawn in the main stem Flathead River from the South Fork confluence downstream to the Flathead Lake inlet. This stretch of river is also a corridor through which many kokanee travel as far as 120 miles upstream to spawn in the North and Middle Forks Flathead River.

The water resources of the basin include the North, Middle, and South Forks Flathead River and various tributaries. In addition to the streams, about 450 lakes including Flathead Lake, one of the largest natural lakes in the Nation, are found in the basin. Annual runoff from the basin amounts to about 19 inches of depth over the watershed (8,500,000 acre-feet). Most of this volume originates above Flathead Lake and about one-third of the volume is contributed by the South Fork Flathead River. Since precipitation occurs primarily in the form of snow, streamflows increase dramatically in the spring during snowpack melt and fall during summer, decreasing to minimum levels in the winter when precipitation accumulates as snowpack.

The economic base of the area is centered on the wood products industry; however, irrigated agriculture (which began developing in the late 1800's), aluminum manufacturing, and recreation are important sectors of the economy. Unemployment continues to be a persistent problem, and a rapid population increase in recent years is straining community services.

The primary problem which this preliminary study has addressed is the need for increased generation of electrical energy in the Pacific Northwest. The satisfaction of power needs in the Flathead basin is directly dependent on whether the Pacific Northwest power system, which supplies most of the basin power imports, can balance future power consumption and generation. Analysis of projected power consumption and electrical generating capability indicates that the Pacific Northwest can expect shortages in the next 20 years. Under critically low streamflow conditions (hydropower generation accounts for about 80 percent of the electrical supply) a net deficit in both peak and average generation will occur in most years. With a repetition of historical streamflows the probability of not meeting total energy loads varies from 36 to 79 percent in each of the next 10 years. Curtailment of firm energy loads, at least once in the next 10 years, is projected at a 99-percent probability.

A second problem addressed is the need to protect, maintain, or enhance the kokanee fishery of the upper basin. A characteristic of the fishery is high productivity in some years and low productivity in other years. The variability appears to be associated with kokanee egg and larvae maturation success in the main stem Flathead River between the South Fork confluence and the inlet of Flathead Lake. Productivity in this stretch depends on the streamflow regimen, which is modulated by the operation of Hungry Horse Dam and Powerplant on the South Fork. Productivity above the South Fork confluence remains fairly constant, accounting for about one-third of the total productivity in some years and all of the productivity in other years. Food resources of Flathead Lake are capable of supporting increased numbers of kokanee. Optimum populations are not known, but a study currently in progress by the Montana Department of Fish, Wildlife, and Parks may provide the answer.

As part of the fishery problem, the potential for a multilevel outlet at the Hungry Horse Powerplant has been addressed. Releases from Hungry Horse Dam remain at a constant 41° F throughout the year. These constant temperature releases may adversely affect the productivity of fish and other aquatic organisms downstream. The altered temperature regimes affect development of aquatic insects, fish feeding patterns, and can induce some spawning migration at inappropriate times.

A third problem addressed is the need for additional public recreation development close to Glacier National Park. Additional camping facilities within the park are needed but are not scheduled to be built because additional development in the park would cause crowding and could reduce the high quality outdoor experience for park visitors. Visitors, finding park facilities filled, will seek nearby campsites outside the park.

Other problems identified include late season irrigation supply shortages, inadequate municipal and industrial water systems, flood damage, some loss of environmental quality in developed areas, and a variety of economic and social problems associated with a rapid growth in population. These problems and related needs were not addressed in this study because resource capability is inadequate, legal or other constraints prevent resource development, or potential solutions appear to lack economic justification.

The existing Hungry Horse Project was completed in 1953. Facilities consist of a dam about 9 miles upstream from the main stem confluence, a powerplant and switchyard at the toe of the dam, a morning glory spillway just upstream from the dam, a visitor center on the right abutment, and a valve house and stilling basin located downstream on the right bank of the South Fork Flathead River. The powerplant contains four generators rated at a total nameplate capacity of 285,000 kilowatts. Water not flowing through the generator turbines can pass through the spillway to the stilling basin whenever reservoir levels are above the spillway crest or through three 8-foot-diameter outlet tubes controlled by hollow jet valves located in the valve house. The Forest Service has developed several overnight camping, picnicking, and boat launching facilities around the 35-mile-long reservoir formed by Hungry Horse Dam.

A plan of development, formulated to help meet identified power, fishery, and recreation needs, was evaluated for economic, environmental, and social well-being effects. The plan is designated as the Outlet Power plan and includes a power feature to increase power generation at Hungry Horse Dam, a reregulating dam to help control power generating flows, and expansion of overnight camping capacity at a recreation facility on Hungry Horse Reservoir.

The Outlet Power plan would increase power generation through construction of a 55,000-kilowatt powerplant at the present outlet works of Hungry Horse Dam. Total installed capacity at the Hungry Horse site with the Outlet Power alternative would be 340,000 kilowatts. The existing outlet works building would be modified to house generators and turbines, and the three existing 8-foot-diameter outlet tubes would be modified for use as penstocks for three equal-sized turbines and for continued use as the outlet works. A new switchyard would be constructed next to the modified outlet works building.

A 51-foot-high reregulating dam would be built about 3.4 miles downstream from the existing Hungry Horse Dam so that downstream flows could be improved (fluctuations decreased) for fishery and environmental quality purposes. The reregulating pool would have a maximum capacity of 1,950 acre-feet and a surface area of 88 acres. Since radial gates controlling the pool would be set at the streambed elevation, the reregulating pool would be a free-flowing stream at minimum elevation. Also included in the alternative is expansion of the existing Lid Creek recreation facility from 22 to 39 overnight camping units. The campground, located on the south shore of Hungry Horse Reservoir, is now and would continue to be operated by the Forest Service (Flathead National Forest).

A display of features and economic, social, and environmental effects of the plan is presented in table 1-1 at the end of this "Summary." A factor crucial to the assessment of fishery impacts is a projected change in operation modes of the Hungry Horse Powerplant. A change to a daily or near daily

peaking mode of operation with elimination of baseload generation is projected to occur as the region develops more thermal generating capacity and hydropower is reserved primarily for meeting peak electrical loads. Effects on the fishery are evaluated based on this projection which is considered probable. However, fishery impacts would be different and could be adverse if a change to the projected operating mode does not occur.

Development potentials, in addition to the alternative discussed above, were given consideration and are discussed later in the report. Some of these have promise and will be reviewed during future feasibility studies.

A feasibility, or detailed, study was authorized by Congress in Public Law 96-375, October 3, 1980. If funded, the Water and Power Resources Service will proceed with the feasibility study. Problems and needs would be reviewed and confirmed, potentials would be analyzed in more detail, and an environmental impact statement and planning report would be prepared for public and congressional consideration. Congress could then authorize construction and provide funds to complete the project.

Several conclusions can be drawn based on the preliminary information summarized in this working document.

1. Undeveloped power potential exists at the Hungry Horse Project. Development of this potential appears economically justified and would help to alleviate a portion of the projected electric power shortages in the Pacific Northwest.

2. Fishery and environmental quality enhancement potentials exist at the Hungry Horse Project and on the main stem Flathead River. Modification of power flows from Hungry Horse Dam by a reregulating reservoir or other means could significantly improve the kokanee fishery of the upper Flathead River-Lake system.

3. Development of additional power potential at the Hungry Horse Project appears to be compatible with fish and wildlife and other interests; however, an assessment of the maximum power development that would be possible and acceptable requires further more detailed study.

4. Limited public recreation development along Hungry Horse Reservoir appears to be economically justified and capable of meeting some of the anticipated needs of visitors to Glacier National Park. However, a recreational needs study of Flathead County is necessary to assess whether additional public facilities are actually needed.

5. A multilevel outlet at Hungry Horse Powerplant could improve the downstream temperature regime. However, damage to the reservoir fishery through use of a multilevel outlet would probably exceed any potential benefits to downstream fisheries.

Table 1-1.--Data Summary of the Outlet Power Plan

Item	Outlet Power
Functions	
Power	X
Fish and wildlife	X
Recreation	X
Facilities	
Power	Construct new 55,000-kilowatt powerplant at existing outlet works. Additional switchyard at new powerplant. 51-foot-high reregulating dam 3.4 miles downstream. Maximum reservoir capacity of 1,950 acre-feet.
Recreation	Enlarge Lid Creek facility from 22 to 39 overnight camping units.
Accomplishments	
Power	
Nameplate rating of total plant (kilowatts)	340,000
Actual added capacity	55,000
Dependable capacity (increase in kilowatt-hours)	105,000
Average annual energy (increase in kilowatt-hours)	86,724,000
Average annual peak energy (increase in kilowatt-hours)	54,668,100
Barrels of #2 distillate saved annually[1/]	160,000
Fishery (annual FSU)[2/]	
Good years	825,240
Poor years	527,916
Recreation (increase in annual visitor-days at full use over No Action alternative)[3/]	4,444
Costs and benefits	
Construction cost (April 1979 price levels)	$36,895,000
Federal investment[4/]	$41,027,000
Annual equivalent project cost (100 years @ 7-1/8 percent)	$ 3,111,030
Annual equivalent benefits (100 years @ 7-1/8 percent)	
Power	$ 5,711,800
Fishery	305,600
Recreation	9,700
Total annual equivalent benefits	$ 6,027,100
Cost per kilowatt installed capacity (additions)	$ 669
Annual financial cost per kilowatt-hour (mills per kilowatt-hour)	41.2
Repayment	
Total annual requirement	$ 6,207,100
Requirement per kilowatt-hour (mills)	41.2

1/ Compared to a thermal plant of similar operating characteristics and that has a capacity equal to that added by the alternative

2/ Fisherman satisfaction units (15.1 FSU equals 1 fisherman-day); good years occur about 5 of each 10 years; affected fishery with the No Action alternative is projected at 359,614 FSU in good years and 190,250 FSU in poor years.

3/ Use would increase to 4,444 visitor-days during the first 11 years of the project and then remain at that level.

4/ Includes construction cost and interest during construction at 7-1/8 percent but does not include investigation costs expended to date

Table 1-1.--(continued)

Item	Outlet Power
Effects	
National economic development	
Net annual benefits	$2,916,070
Benefit-cost ratio (7-1/8 percent discount rate)	1.94
Regional development	
Net annual benefits to Flathead County	$1,992,800
Net short-term employment to Flathead County	205
Net long-term employment ot Flathead County	3
Environmental quality	
Ecological components	Major positive effect on kokanee fishery. Positive effect on aquatic insects and overall productivity of main stem of Flathead River. No effect on wildlife. Slightly negative effect on plants (inundation of 45 acres in reregulating pool).
Physical components	Slightly negative effect on air quality during construction and on scenic quality at site of reregulating pool.
Cultural components	None
Recreational components	Major improvement in sport fishery. Slight decrease in open space (reregulating pool).
Social well-being	
Area	Improved energy production and short-term job opportunities.
	Major improvement in sport fishery.
Community	Residents support increased power production and improved fishery.
Individual	Improved safety from reduced flow fluctuations in South Fork and main stem Flathead River.
	Increased traffic hazard and air and water pollution during construction.
	Increased short-term employment opportunities.
	Major improvement in lake and river fishing success.
National emergency preparedness	Improved emergency energy capacity.
Aggregate social effects	Beneficial, related primarily to improved fishery.

S E T T I N G

LOCATION

The existing Hungry Horse Dam and Powerplant are on the South Fork Flathead River at a location about 20 miles northeast of Kalispell and about 15 miles south of Glacier National Park in northwest Montana. The land surrounding the South Fork lies within the Flathead National Forest. The narrowest definition of the study area for this investigation is Hungry Horse Reservoir and Dam and the South Fork Flathead River from the dam to the confluence with the main stem. This area was chosen as a natural extension of the existing Hungry Horse Project, and development considerations were eventually limited to this area.

However, problems and needs, resource base, and potential impacts of development for a larger area were considered during plan formulation and evaluation. The extent of this area varies with the aspect under consideration. The Pacific Northwest Utilities Conference West Group area (see "Problems and Needs" chapter) was selected for purposes of analyzing hydropower problems and needs and plan effects regarding power production. This area was selected because Hungry Horse Dam is tied hydraulically to other hydropower development on the Columbia River and the local electrical system is part of the integrated Pacific Northwest load area. In contrast, the Flathead Lake-upper Flathead River system was considered a fishery planning unit for this study. This extensive area was selected because spawning in upstream areas and successful fry development in the main stem is essential to the continued fish production in the lake and could be affected by any development on the South Fork.

WATER AND RELATED RESOURCE DEVELOPMENT

Water Resources

The Flathead River basin, the most northeasterly of the basins within the Columbia River system, covers approximately 8,830 square miles of area including 430 square miles located in Canada. Resources within the United States include 3,500 miles of streams, 450 lakes, and ground water. The dominant stream is the Flathead River, including the North, South, and Middle Forks, portions of which have been included into the National Wild and Scenic Rivers System. Other major streams include the Whitefish, Stillwater, Swan, Little Bitterroot, and Jocko Rivers. Flathead Lake, one of the largest natural freshwater lakes found in the continental United States, is a dominant feature of the basin. The lake is partially controlled by Kerr Dam.

The North Fork Flathead River rises in the McDonald Range in Canada and flows southeasterly, forming the western boundary of Glacier National Park. About 40.7 miles of the North Fork from the Canadian border to Camas Creek is classified as a scenic river, and about 17.6 miles from Camas Creek to the confluence with the Middle Fork is classified as a recreational river.

The Middle Fork rises in mountains much further south in Montana and flows northwesterly, forming a portion of the southern boundary of Glacier National Park, to its confluence with the North Fork. From its headwaters to Bear Creek, about 46.6 miles, the Middle Fork is classified as a wild river. The remainder of the Middle Fork and the main stem Flathead River to the South Fork confluence is classified as a recreational river (about 54 miles).

The South Fork parallels the Middle Fork emptying into the main stem Flathead River about 5 miles south of the Middle Fork confluence. The South Fork is classified as a wild river from its headwaters to the Spotted Bear River confluence (51.3 miles) and as a recreational river from Spotted Bear River to Hungry Horse Reservoir (8.8 miles).

The main stem Flathead River flows west from the South Fork confluence and then south to converge with the Whitefish and Stillwater Rivers and empty into Flathead Lake. South of the lake the Flathead River flows generally south and west to empty into the Clark Fork River. Water from the Flathead basin eventually reaches the Columbia River through the Clark Fork River and the Pend Oreille River which converges with the Columbia River just north of the Canadian border.

Slightly over 8.5 million acre-feet of water is discharged to the Clark Fork River from the Flathead River in an average year. This amounts to about 19 inches of depth over the watershed, a high amount for an inland western basin. Most of this discharge derives from above Flathead Lake; average annual flow of the Flathead River at Columbia Falls is 7.1 million acre-feet. Slightly more than one-third of the flow above Columbia Falls is contributed by the South Fork. The average annual runoff of the South Fork at Hungry Horse Dam is about 2.6 million acre-feet. Peak unregulated flows resulting from snowmelt runoff normally occur during the month of June. Natural minimum flows occur during mid-winter when precipitation accumulates as snowpack.

Ground water is available in many parts of the basin and some areas can support heavy ground water development. Deep artesian, shallow artesian, perched, gravel, and sand aquifers are found north of Flathead Lake. Well yields of up to 1,350 gallons per minute have been developed in many parts of the basin, but yields of 20 gallons per minute are more common for domestic use. South of Flathead Lake deep artesian water is available in many areas while shallower aquifers provide limited quantities of water.

Water Quality

Quality of the basin water resources is excellent compared to other streams in the Northwest and in the Nation. In the northern part of the basin nutrient levels tend to be very low except during spring runoff. During the spring turbidity occurs and levels of some nutrients increase, but after flows decrease turbidity generally disappears and nutrient levels decrease. In the lower part of the basin irrigation return flows tend to increase nutrient levels but general water quality remains very good.

Water quality of Hungry Horse Reservoir is excellent. Low nutrient levels and high clarity are characteristic of this oligotrophic body of water. Distinct thermal stratification along the entire length of the reservoir occurs during the summer. Although surface water temperature varies seasonally, deep water at the elevation of the river and power outlets remains near 41° F throughout the year.

South Fork water temperatures below Hungry Horse Dam show virtually no seasonal changes, remaining near 41° F throughout the year. Under natural conditions (no impoundment) temperatures would be expected to vary from near 32° F in the winter to over 60° F in the summer. In the main stem below the South Fork confluence seasonal and daily temperature fluctuations are reduced compared to natural conditions. Although water temperatures are cooler in the summer than under normal conditions, large daily fluctuations in water temperature mask this condition. However, in the winter the main stem, which under natural conditions would remain at a near constant 32° F, is warmed as much as 8° F.

Storage and Power Development

The major water storage in the basin is provided by Flathead Lake and Hungry Horse Reservoir. Major power developments are Kerr Dam and Powerplant on Flathead Lake and Hungry Horse Dam and Powerplant.

Hungry Horse Project

The Hungry Horse Project, which consists of the dam, reservoir, and powerplant, is located on the South Fork. Major authorized purposes are flood control and hydropower generation. Construction of the dam and powerplant was completed in 1953.

Hungry Horse Dam is a concrete arch gravity structure with a crest length of 2,115 feet and a height of 564 feet. The dam is 39 feet wide at the top and 330 feet wide at the base. The reservoir formed by the dam is 35 miles long, covers 23,800 surface acres, and contains 2,982,000 acre-feet of water in active storage when full. The powerplant contains four generators having a total nameplate rating of 285,000 kilowatts that are operated at a continuous overload of 328,000 kilowatts when needed.

Hydroelectric generation from the powerplant averages slightly less than 1 billion kilowatt-hours annually and is marketed by the Bonneville Power Administration. The principal power benefit of the project, however, comes from the stored floodwaters which are released downstream during the fall and winter. In an average year about 4.6 billion kilowatt-hours of energy are generated from these releases as the water passes through 19 downstream powerplants.

Flood control operations at the Hungry Horse Project reduce flooding in the Flathead Valley. These operations also reduce flooding and peak flows farther downstream by 10 to 25 percent. Water courses affected include the Clark Fork River in Montana and Idaho, the Pend Oreille River in northern Idaho and Washington, and the Columbia River from the confluence with the Pend Oreille River in Canada to Grand Coulee Dam in north-central Washington.

Hungry Horse is a cyclic storage project; the reservoir has more storage capacity than the average annual inflow provides. The reservoir could be drafted over a series of years (the number of years depending on inflow) before reaching a minimum conservation level. Under normal operation drafts are limited so that the reservoir can be refilled each year. Drafting begins in the fall and continues throughout the winter to provide electric power and space for flood control. Spring releases, based on anticipated runoff, are made to provide flood control and allow the reservoir to refill by July. From July through September an attempt is made to maintain a full reservoir, pool elevation of 3560 feet, for recreation. The cycle is then repeated beginning in October. Essentially all of the releases are through the powerplant, and water is seldom spilled downstream through the spillway or outlet works.

While the annual drafting and filling cycle of the reservoir follows a regular pattern, monthly, weekly, and daily discharges from the powerplant are irregular. Decisions related to hourly and daily operation are made by the Bonneville Power Administration (BPA) control center in Vancouver, Washington. Requests for power vary with weather conditions, outages at other plants, and other factors. As a result, the powerplant may be shut down or in partial or full operation for hours or several consecutive days. One or two generators may be operated continuously for longer periods to serve baseload needs. Discharge from the powerplant (South Fork flows below the plant) can vary from a minimum of 145 cubic feet per second (ft^3/s) to about 11,420 ft^3/s, but variations are generally less. Greatest flow variations normally occur during winter months when peakloads are met.

Under normal reservoir operation the head on the generators ranges from 398 feet to 488 feet at full pool level. Rated head of the generators is 398 feet and hydraulic capacity of the turbines and penstocks is 11,420 ft^3/s at this head. Although hydraulic capacity increases at heads above 398 feet, the additional capacity cannot be used because electrical limits of the generators would be exceeded. At heads less than 398 feet hydraulic capacity, powerplant efficiency, and power generating capability decrease.

Kerr Dam

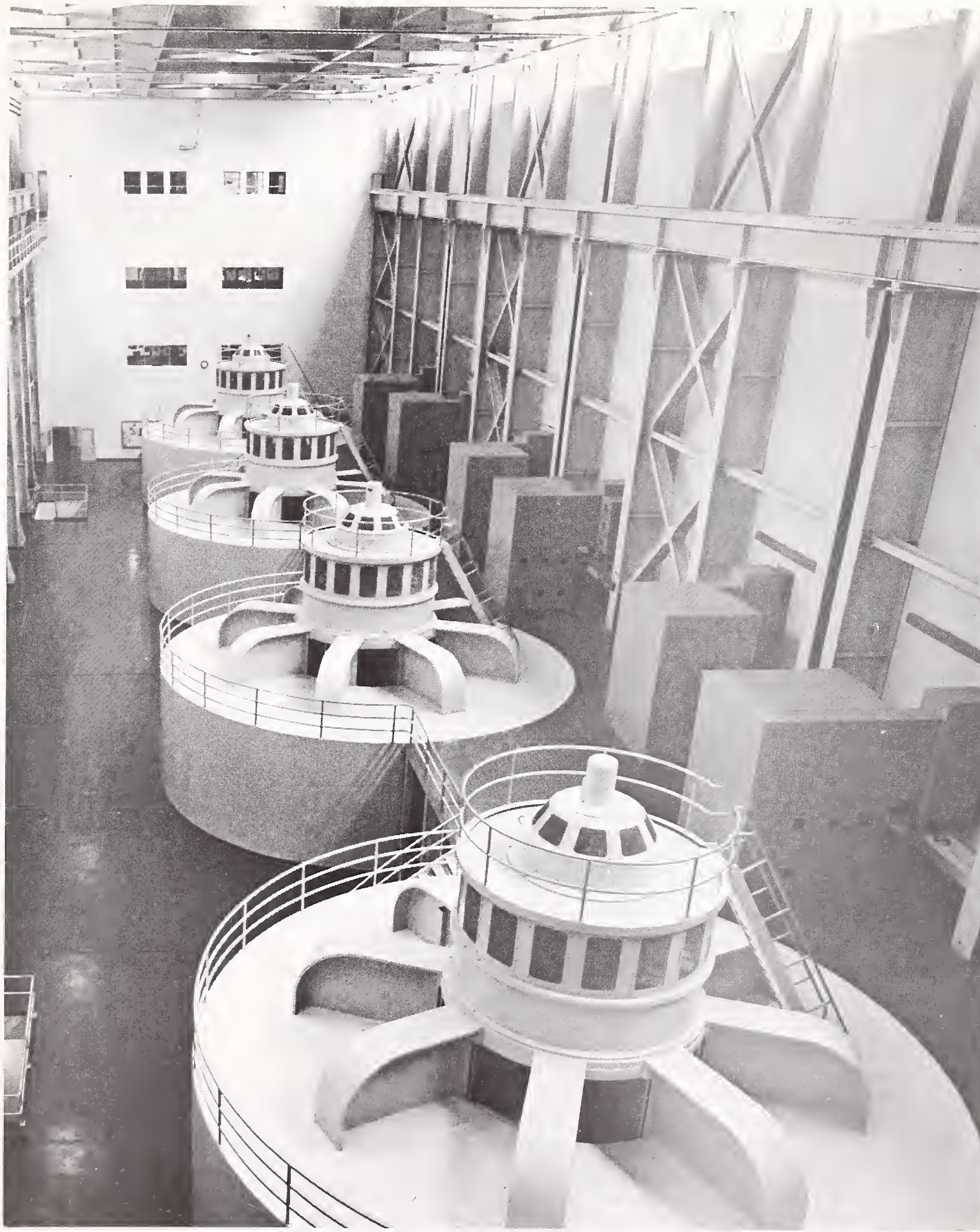
Kerr Dam and Powerplant, located just downstream from the natural outlet of Flathead Lake, were completed in 1938 by the Montana Power Company. The powerplant has an installed nameplate capacity of 168,000 kilowatts.

Hungry Horse Dam and Reservoir (P447-100-236)

Visitor Center and parking area (foreground), powerplant, and switchyard (toe of dam) at the Hungry Horse Project. Also partially visible are the glory hole overflow spillway (round structure on left) and log boom which acts as a safety barrier to boaters and limits collection of floating debris along the dam. (P447-100-159)

Narrow canyon of the South Fork Flathead River downstream from Hungry Horse Dam. The top of the powerhouse (immediate foreground) and the outlet building (slightly downstream on the right) are visible. (P447-100-201)

Hungry Horse Dam, powerhouse, and switching yard. The outlet controls and facilities are housed in the small building on the left. The staircase structure to the left of the outlet building is the stilling basin of the overflow spillway. (P447-100-196)



Hungry Horse Powerplant contains four equal-sized generators having a total nameplate rating of 285,000 kilowatts. (P447-100-207)

Construction of the dam made it possible to raise the natural level of the lake, the upper 10 feet of which is now controlled by the dam for power generation and flood control purposes. At full capacity, elevation 2893 feet, Flathead Lake covers 126,000 surface acres and has an active capacity of 1,219,000 acre-feet (total capacity of 1,826,000 acre-feet). At a lake level of 2883 feet above sea level, the natural outlet channel has a hydraulic capacity of 5,000 ft^3/s.

Big Fork Dam

Big Fork Dam and Powerplant were constructed on the Swan River, a tributary to Flathead Lake, by the Pacific Power and Light Company in 1901. The dam and powerplant, nameplate capacity of 4,150 kilowatts, are located about 1.5 miles upstream from the mouth of the river.

Big Creek Dam

Big Creek Dam and Powerplant are located on Hell Roaring (Big) Creek which empties into the southern end of Flathead Lake. The facility, which began operation in 1916, is owned by the Flathead Irrigation District. Installed nameplate rating is 360 kilowatts.

Irrigation

Irrigation was introduced into the Flathead Valley about 1885. Since that time irrigation development has been continued by individual farmers, private irrigation districts, Water and Power Resources Service, and the Water Resources Division of the Montana Department of Natural Resources and Conservation. At present, approximately 166,700 acres are under irrigation. About 123,000 acres of these lands are located on the Flathead Indian Reservation in the Flathead Irrigation Project. This project, constructed by the Water and Power Resources Service, is now operated by the Bureau of Indian Affairs.

The diversion requirement for currently irrigated lands in the Flathead basin exceeds 800,000 acre-feet. About 47 percent of this is used in crop consumption and evapotranspiration, and the remaining 53 percent is return flow.

Recreation

Major recreation resources in Flathead County include Glacier National Park, Flathead Lake, Bob Marshall and Great Bear Wilderness Areas, Jewel Basin Hiking Area, Flathead River units of the National Wild and Scenic River system, and Hungry Horse Reservoir. In addition, there are significant quantities of Federal, state, and private forest lands that are available for recreation use. Major nonurban recreation activities include camping, picnicking, swimming, sightseeing, fishing, boating, water-skiing, hunting, horseback riding, and snow related activites.

Recreation facilities at Hungry Horse Reservoir are operated by the Forest Service. These facilities include 119 camping units, 66 picnic units, and 12 boat launching ramps.

ENVIRONMENTAL CHARACTERISTICS

Climate

The climate of the Flathead basin is primarily a Pacific maritime type. Pacific air influences which are dominant during the winter moderate Arctic airflows from the north. Winter temperatures are generally mild with an average of 26° F at Kalispell. However, Arctic airflows ocassionally spill into the basin and have produced temperature extremes of -38° F at Kalispell. Summer temperatures are cool with an average of 62° F and an extreme of 105° F recorded at Kalispell.

Precipitation throughout the basin is dependent on altitude and topography. Mountains intercept moisture laden airflows from the Pacific and cause rain shadow effects in adjacent valleys. The general precipitation pattern that results is semiarid valleys that receive 15-20 inches of moisture annually and wet mountaintops that receive annual precipitation of up to 80 inches. Much of the precipitation that falls in the mountains accumulates as a heavy snowfall. Snowfields persist into summer and provide a source for the numerous streams.

The growing season in most valleys is short, ranging down to 90 days. Flathead Lake reduces daily temperature fluctuations in the Flathead Valley, and near the lake the frost-free growing season is 140 days. Orchardists have taken advantage of the exceptional conditions along the lake to produce commercial quantities of sweet cherries.

Physiography

The Flathead River basin lies along the west slope of the Continental Divide in the Rocky Mountain Physiographic Province. The upper part of the basin consists of a series of northwest-trending mountain ranges with interfingered tributaries of the Flathead River. This basic form was initiated by a broad regional uplift, combined with faulting about 60 to 70 million years ago, and has remained essentially unchanged to the present.

Flathead Valley in the western portion of the basin is a part of the Rocky Mountain Trench, a large structural depression extending from northern British Columbia to the Missoula area south of the Flathead River basin. This valley was initiated by downfaulting and since has been partially filled with eroded material from nearby mountains and glacial deposits. Outwash sediments from receding glaciers accumulated and the Flathead River and its tributaries entrenched their courses about 100 feet into the consolidated valley-fill deposits. The river and its tributaries have continued to mature, creating broader flood plains and more gentle gradients.

Valleys of the North, South, and Middle Forks Flathead River are sharper in relief and lie between northwest-trending mountains. Rocks from the Precambrian Belt Series outcrop on mountains and Tertiary age sediments eroded from the mountain ranges fill the intermontane valleys. These sediments are extensively covered by glacial deposits from glaciers that may have persisted to as recently as 10,000 to 13,000 years ago. The South Fork lies between the Flathead Range to the east and the Swan Range to the west in a valley that varies from 12 to 28 miles wide.

Large elevation differences within the Flathead basin provide a contrast between the mountains and the Flathead Valley. Much of the Flathead Valley lies between 2900 and 3000 feet above sea level, while the elevation of some peaks in the drainage is over 10,000 feet. Elevation at Hungry Horse Dam is 3050 feet.

Soils

Immature or incomplete development is a characteristic of the soils of the upper Flathead basin. Soils on mountain slopes and in narrow valleys tend to be rocky, thin, and nutrient poor. Although these soils have low agricultural value, they are able to support a luxuriant coniferous forest because precipitation is abundant and conifer nutrient requirements are low.

Two types of soils are characteristic of the Flathead Valley north of Flathead Lake. One type is rocky, poorly drained, and of marginal use for agriculture. The other type is generally deep, well structured, and well drained but requires fertilizers to maintain nutrients for cultivated crop production.

Soils south of Flathead Lake are generally similar to those found in the north, but the proportion of deep, well-structured soils is much greater.

Vegetation

Vegetation in the Flathead drainage reflects the varied climate and physiography, varying from semiarid grasslands to subalpine associations. South of Columbia Falls much of the Flathead Valley has been cultivated, but some natural grasslands remain and these are dominated by bluebunch wheatgrass and other bunchgrasses. Higher grasslands and mountain parks are typically dominated by fescues.

The Flathead River flood plain supports extensive forests dominated by cottonwoods but often includes Englemann spruce and Rocky Mountain juniper. The understory, especially near the river, generally contains abundant shrubs such as willows, alders, and red-osier dogwood.

Streambanks and valleys at higher elevations are generally bordered by dense stands of shrubs including willows, alders, and aspen. These riparian woodlands also include birches and conifers and grade into the nearby forests.

Forests at low elevations are predominantly a ponderosa pine/bluebunch wheatgrass association. Climax forests on more moist sites are Douglas fir/snowberry and Douglas fir/pinegrass associations. Large areas were burned during the 1900's and are now covered by shrubs and other successional vegetation. Western larch and lodgepole pine are early successional dominants, and extensive areas are now covered by dense stands of lodgepole pine. At higher elevations subalpine fir and Engelmann spruce associations are predominant.

Forests on the mountainous slopes near Hungry Horse Reservoir consist primarily of lodgepole pine and western larch. Vegetation along the streambank of the South Fork below Hungry Horse Dam includes birch and aspen but is best characterized as an extension of the surrounding forest.

Wildlife Habitat

Habitat for wildlife is both extensive and varied in the Flathead River basin. Grasslands, flood plains, wetlands, and marshes are the predominant habitats at lower altitudes. Streambanks and valleys in the higher mountains often support dense shrublands. Forest associations found at higher altitudes range from ponderosa pine at lower altitudes to a variety of associations dominated by Douglas fir, spruce, cedar, or hemlock. Forests of subalpine fir and whitebark pine are found near the timberline. A true alpine habitat, characterized by low mat-forming plants and a general absence of vascular plants, is present at the highest altitudes.

Fish

The fishery of the Flathead Lake-Flathead River system is nationally renowned and depends entirely on natural production. The main stem Flathead River (from confluence of Middle and North Forks to Flathead Lake) is one of the seven streams that the State of Montana classifies as a blue ribbon fishery.

This fishery, which consists of natural and introduced species, is dependent upon the entire Flathead River-Lake system which functions as a complete ecological unit. The river and tributaries provide necessary spawning and fry development areas, while the lake provides a more abundant source of food for faster growth and adult development. Without the tributaries or access to them through the main rivers the lake populations would diminish, and without the lake there would be fewer fish in the tributaries.

Approximately one-half of the species living in the lake are considered native to the drainage, but these species make up a relatively small portion of the game fish population. Indigenous game species of major importance are westslope cutthroat trout, Dolly Varden, and mountain whitefish. Introduced species include brook trout, rainbow trout, lake trout, and kokanee salmon. Other game fish include yellow perch, large mouth bass, and northern pike. Nongame fish include squawfish, peamouth, and suckers.

Three classifications have been established according to fish behavior patterns. Most Dolly Varden, cutthroat trout, kokanee salmon, and some mountain whitefish are classified as adfluvial. These fish live their adult lives in the lake and migrate into smaller tributaries to spawn. Dolly Varden and cutthroat live in the river and its tributaries for about 2 years and then migrate to the lake. Cutthroat may make two spawning runs during their average lifespan of 6 years. Whitefish and kokanee salmon young migrate downstream soon after hatching and become adults in 2 to 4 years. Kokanee salmon are a landlocked form of the Pacific sockeye salmon and die soon after spawning.

Fluvial populations of Dolly Varden, westslope cutthroat, and mountain whitefish exist in the system and live their adult lives in the larger streams, spawning in the smaller streams. Some westslope cutthroat trout and mountain whitefish live their entire life cycle in a small segment of a lake or stream and are termed resident fish. The migratory behavior of various fish species present in the Flathead Lake-Flathead River system is shown below.

Species	Adfluvial Races	Fluvial Races	Resident Stream Races
Dolly Varden	Yes	Yes	Yes
Westslope cutthroat trout	Yes	Yes	Yes
Mountain whitefish	Yes	Yes	Yes
Brook trout	Limited	Yes	Yes
Kokanee salmon	Yes	No	No
Rainbow trout	No	No	Yes
Lake trout	No	No	No

The main stem Flathead River is a corridor for fish migrating from the lake to upstream spawning areas. Adfluvial races of cutthroat trout migrate as far as 80 miles upstream, and Dolly Varden travel as far as 120 miles to reach spawning beds in the Middle and North Fork Flathead Rivers. Kokanee salmon, which provide about 75 percent of the Flathead Lake fishery, spawn in the main stem or pass through the main stem to upstream spawning beds. One of the more important of the upstream spawning areas is McDonald Creek, just above the confluence with the Middle Fork Flathead River. More than 300 bald eagles and several grizzly bears are often drawn to the area to feed on kokanee during the fall spawning run.

Fish habitat in the South Fork Flathead River below Hungry Horse Dam is limited. Most of the substrate is cobble and rubble with a few small pockets of gravels in protected areas near large rocks. Some kokanee spawning occurs in at least one small area of pea-sized gravel below the dam. A few resident cutthroat trout and mountain whitefish are present.

Aquatic Macroinvertebrates

Productivity and diversity of aquatic macroinvertebrates, which form an important food base for fish, are very different in the main stem and the South Fork Flathead River below Hungry Horse Dam. The main stem has a diverse and productive population of aquatic insects and other macroinvertebrates. In contrast, the number of species in the South Fork is relatively small, and aquatic insect populations are practically absent. Bottom-dwelling invertebrates are composed primarily of midge species, but a few mayfly, stonefly, and caddisfly species are present. Productivity of invertebrates in the South Fork is generally poor because rapid and frequent fluctuation limit the suitable habitat and because many species cannot develop to maturity in the year-round cold waters.

Wildlife

Wildlife of the basin is diverse. Significant species found in the river valleys include white-tailed deer, ruffed grouse, river otter, beaver, muskrat, mink, raccoon, and black bear. In addition, there are various shore birds, songbirds, and migratory waterfowl. Bald eagles migrate through the area and some winter in the basin.

Animals present in the mountains include white-tailed deer, mule deer, black bear, grizzly bear, gray wolf (northern Rocky Mountain wolf), moose, elk, bighorn sheep, mountain goat, fisher, marten, mountain lion, lynx, ruffed and spruce grouse, and numerous small birds and mammals.

The area just below Hungry Horse Dam provides marginal habitat for white-tailed deer, ruffed grouse, songbirds, rodents, otter, mink, black bear, and possibly an occasional grizzly bear. A mule deer and elk migration route reportedly crosses the South Fork Flathead River just below the dam.

Endangered and Threatened Species

Several species listed in the United States list of endangered and threatened species occur in the upper Flathead River basin. These species include the gray wolf, peregrine falcon, and bald eagle which are listed as endangered and the grizzly bear which is listed as threatened.

The gray wolf is found in limited numbers in the basin. The grizzly bear ranges over much of the basin and has been sporadically observed along the South Fork Flathead River. Bald eagles winter in the basin and may occasionally feed on fish in the South Fork. At present there is no evidence of eagle nesting along the South Fork. Peregrine falcons probably pass through the basin during migration.

Cultural Resources

A class I cultural resources survey, consisting of a literature review and contact with appropriate state officials, agencies, institutions, and individuals, was made during the appraisal investigation. No cultural resources or properties listed or eligible for listing in the National Register of Historic Places are known to occur in the immediate area of a proposed reregulating dam and reservoir or on lands administered by the Water and Power Resources Service. The class I survey indicates a low probability that a field investigation, class II cultural resources survey, would uncover any cultural resource sites in the project area. A class II survey would be conducted during more detailed feasibility investigations.

The nearest National Register properties are historic buildings in Kalispell and West Glacier. Other known cultural resources nearby are the Mount Aeneas Indian Trail and the Baptiste Cabin, which are listed as places of historical significance by the Montana Historical Society. None of these known cultural resources are on lands administered by the Water and Power Resources Service and none would be affected by implementation of alternatives considered in this investigation.

SOCIOECONOMIC CHARACTERISTICS

History

When white men moved into the Flathead basin about 1807 they encountered three major Indian tribes--the Kootenai, Salish (or Flathead), and Pend Oreille. Only the Kootenai Tribe lived in the basin at the time, but Salish and Pend Oreille occasionally traveled through or hunted in the area. Fur trade flourished for a short period and was followed by mineral prospecting, mining, and extraction. Settlement during this period continued at a slow pace until the middle 1880's when navigation of Flathead Lake and River developed. Arrival of the railroads in 1891 provided further stimulus to settlement, and trade centers developed at the present sites of Kalispell, Whitefish, Polson, and Columbia Falls.

Agriculture developed slowly although individual farmers practiced irrigated agriculture as early as the mid-1880's. Increased population and creation of the Flathead Irrigation Project in the early 1900's provided impetus to agricultural growth. Logging has been important to the area since the earliest days when wood products were used for mine timbers, fuel, and domestic construction. Later the railroad required huge supplies of rail ties, and logs were sawed for export. Kerr Dam, with a generating capacity of 180,000 kilowatts, was constructed on Flathead Lake in 1938, and later Hungry Horse Dam, with a capacity of 285,000 kilowatts, was completed on the South Fork Flathead River in 1953. In 1953 Anaconda Aluminum Company constructed an aluminum reduction plant at Columbia Falls and commenced production in 1955.

Population

The population of Flathead County grew from 1960 to 1970 more rapidly than the state or Nation. Estimated population growth in this period was about three times the national growth rate and twice the state growth rate. Bureau of the Census data indicate that the county increased in population from 32,965 in 1960 to 39,460 in 1970 and continued to grow to about 45,400 in 1976. The resulting population density in 1976 was 8.8 persons per square mile compared with state and national averages of 5.2 and 60.9, respectively.

Inmigration and natural increase contributed about equally to population growth in the 1960's, but in the 1970's inmigration accounted for approximately three-fourths of the increase. Two factors limiting growth in this period are the decline in the birth rate, from 23 births per 1,000 population in 1960 to 14 births per 1,000 in 1975, and outmigration of the 20-24 age group in response to a lack of educational and full-time employment opportunities in Flathead County.

Community Services

County and city police departments provide law enforcement services to the area, supplemented by state personnel as appropriate.

Fire protection in Flathead County is provided by a full-time municipal fire department in the service area of Kalispell and by volunteer fire districts elsewhere. Strain has been placed on school districts by the recent population growth. At present, enrollment nearly fills or exceeds space capacity in many schools.

The housing supply throughout the county is generally adequate to meet needs. However, some housing is considered substandard.

Employment

The economic development of Flathead County has been based primarily on manufacturing, forestry, and agriculture. In recent years tourism has become important in the economy and growth is expected to continue.

Employment data for 1976 indicate that the largest sectors are manufacturing (23.3 percent), wholesale and retail trade (22.0 percent), and government (21.9 percent). Agriculture accounted for approximately 5 percent of the total county employment in 1979.

Manufacturing accounted for 30 percent of Flathead County earnings in 1976. Wood products represent 52 percent and primary metals (aluminum) represents about 33 percent of the manufacturing income. Other primary sources of income generated are government (17 percent) and wholesale and retail trade (17 percent). Farm income represented 4 percent of the total earnings.

Per capita income for 1976 in Flathead County was $5,587. This compares to State, $5,691, and national, $6,395 averages.

Unemployment has been a persistent problem in Flathead County. In 1974 county unemployment was 11.5 percent compared to State (6.5 percent) and national (5.6 percent) unemployment. Flathead County is listed as a labor surplus area by the U.S. Department of Labor.

Land Use and Ownership

The Montana portion of the Flathead River basin includes all or portions of seven counties. All of Lake County and most of Flathead County lie within the basin boundary. Relatively small but significant portions of Sanders, Missoula, and Powell Counties also lie within the basin. The remaining parts of the basin include insignificant portions of Lincoln County and Lewis and Clark County. Total acreage of the Montana portion of the basin amounts to about 5,406,000 acres (8,450 square miles).

Slightly over 60 percent of the Flathead basin land area is in public ownership. Federally managed lands include Glacier National Park; National Bison Range; Flathead National Forest, including the Bob Marshall, Mission Mountains, and the Great Bear Wilderness Areas; and portions of Kootenai and Lolo National Forests. State land holdings amount to about 5 percent of the area and include the Stillwater, Coal Creek, and Swan River State Forests.

The Flathead Indian Reservation located in primarily Lake and Sanders Counties covers about one-fourth of the basin. The reservation totals 1,244,940 acres of which about one-half is held in tribal trust or in private Indian ownerships. The remaining portion of the reservation is primarily in private non-Indian ownerships, and a small portion is owned by the state or included in the National Bison Range and the Pablo and Ninepipe National Wildlife Refuges located on the reservation.

A major part, nearly 77 percent, of the basin is covered by forests, and 3.6 percent of the basin is covered by large bodies of water. Forest uses include timber, recreation, and fish and wildlife. Nonforested lands are used primarily for agriculture, including rangeland (8.5 percent) and cropland and pasture (7.3 percent). Other uses include land for urban areas, built-up areas, special use areas, and barren lands totaling about 3.7 percent of the basin area.

Within the Flathead Valley approximately 468,000 acres of potentially irrigable lands have been identified. At present approximately 167,000 acres are irrigated and about 229,000 acres are dryland farmed. Of the total irrigated acreage about 74 percent (123,000 acres) is served by the Flathead Irrigation Project on the Flathead Indian Reservation.

Flathead County totals approximately 3,190,000 acres of which about 89,000 acres are covered by large bodies of water. Public ownership of land is proportionately greater in Flathead County compared to the Flathead basin. Federally owned and managed lands, primarily Glacier National Park and Flathead National Forest, comprise about 76 percent of the county land area. State land holdings are centered in the Stillwater and Coal Creek State Forests.

Almost 90 percent of the county land area is covered by forests, while croplands and pasturelands amount to only 266,000 acres (about 4 percent of the land area) of which 33,000 are irrigated. The remaining land area consists of barren lands and urban or built-up areas.

Publicly owned lands have been managed primarily for forest products and recreation. Private lands have historically been used for timber production, cattle grazing, and crop production; however, agricultural use is decreasing through conversion of land to subdivisions and other uses.

Table 2-1 summarizes land cover and use by county in the Flathead River basin.

Table 2-1.--Area, Land Cover, and Use, Flathead River Basin1/
(Acres, 1970)

County	Acres in Basin	Large Water Areas	Total Land Area	Non-Federal2/ Cropland and Pasture Irrigated	Non-Federal2/ Cropland and Pasture Dry	Non-Federal2/ Cropland and Pasture Total	Non-Federal2/ Range	Non-Federal2/ Forest	Non-Federal2/ Urban Built-up, and Other3/	Non-Federal2/ Total
Flathead	3,188,620	88,586	3,100,034	33,150	99,900	133,050	18,100	563,734	32,760	747,644
Lake	1,055,880	103,945	951,935	112,250	104,800	217,050	176,800	359,552	24,600	778,002
Sanders	488,110	600	487,510	18,450	23,050	41,500	215,300	202,316	9,980	469,096
Missoula	324,980	1,616	323,364	2,850	650	3,500	0	150,694	1,170	155,364
Powell	258,900	500	258,400	0	0	0	0	0	0	0
Lincoln	46,980	0	46,980	0	300	300	0	30,680	280	31,260
Lewis and Clark	42,080	0	42,080	0	0	0	0	0	0	0
Total	5,405,550	195,247	5,210,303	166,700	228,700	395,400	410,200	1,306,976	68,790	2,181,366

County	Federal Forest	Federal Range	Federal Barren and Special Use4/	Federal Total
Flathead	2,231,500	25,000	95,890	2,352,390
Lake	147,000	12,975	13,958	173,933
Sanders	8,800	8,555	1,059	18,414
Missoula	158,000	0	10,000	168,000
Powell	247,400	1,000	10,000	258,400
Lincoln	15,720	0	0	15,720
Lewis and Clark	42,080	0	0	42,080
Total	2,850,500	47,530	130,907	3,028,937

1/ Flathead River Basin Level B Study, September 1976; State Study Team, Montana Lepartment of Natural Resources and Conservation, and Pacific Northwest River Basins Commission
2/ Includes 564,700 acres of Indian trust lands
3/ Includes 14,090 acres of small water areas and 54,700 acres of urban and built-up or special use areas
4/ Includes 114,500 acres of barren land

PUBLIC INVOLVEMENT

At the initiation of the preliminary study Federal and state agencies that might have an interest in the study were provided with information on the scope, nature, and some of the potentials that would be explored in the study. Annual status reports were provided to such agencies during the course of the investigation. Information to the public was provided through the news media.

People affiliated with various interest groups, members of local planning organizations, and personnel from government agencies in the Flathead River basin were contacted for their views and concerns. Discussions included requests for information on current and projected problems and needs, public views of resource values, and the public perception of constraints to development.

State and Federal fishery and wildlife agencies provided additional detail in identifying problems and needs and in plan evaluation.

This working document summarizes problems, needs, constraints, and development potentials in the study area. Comments received from the public on this information will be of value in conducting a future feasibility study.

PROBLEMS AND NEEDS

Problems and needs for this study were identified primarily from existing secondary sources. These sources include the following:

Flathead River Basin, Level B Study; September 1976; State Study Team, Montana Department of Natural Resources and Conservation, and Pacific Northwest River Basins Commission.

Review of Power Planning in the Pacific Northwest, Calendar Year 1979; July 1980; Power Planning Committee, Pacific Northwest River Basins Commission

Upper Flathead River Basin Study; January 1977; Montana Department of Natural Resources and Conservation

Clark Fork of the Columbia River Basin Cooperative Study; 1977; U.S. Department of Agriculture and Montana Department of Natural Resources and Conservation

Other secondary sources used to identify problems included various technical memorandums on power, irrigation, and recreation prepared for the Pacific Northwest River Basins Commission.

In addition to secondary sources, discussions with some local residents were conducted to determine local perceptions of problems and needs.

The problems identified include the following:

1. Energy consumption within the basin is greater than the energy produced in the basin. Growth in energy consumption both within the basin and in the Pacific Northwest in general is much greater than anticipated construction of new facilities can supply.

2. Fish and wildlife habitat is being degraded in some areas as a result of competing land use.

3. Demand for public recreation facilities may be greater than can be met by present and anticipated supply.

4. Operation modes of Hungry Horse Dam for flood control and power generation continue to pose problems for recreationists and fish resources. Rapid rises in downstream water levels can strand fishermen, present hazards to rafters, and affect upstream spawning kokanee. In addition, long periods of minimum flows during the winter dewater kokanee redds and reduce fish productivity.

5. Flood damage in the basin continues to be significant, and the dollar value lost could increase if development within flood plains continues.

6. Inadequate treatment of municipal and residential sewage and some agricultural and logging activities are degrading local water quality within the basin.

7. Water supplies for municipal and industrial use in some areas of the basin have a variety of problems including quality, reliability, and adequacy of delivery systems.

8. More than three-fourths of the irrigated agricultural lands suffer late-season water shortages, and some lands are inadequately drained.

9. Agricultural lands are being lost to residential development and other land uses.

10. Unemployment for the basin is higher than state and national averages.

11. Rapid population growth in the basin has intensified or created several economic and social problems. These include some substandard housing and stressed educational, law enforcement, and fire protection services.

12. A continuing problem related to water resource planning and development is that the water rights and entitlement of the Salish and Kootenai Indian Tribes have not been fully determined.

Several of the present problems have arisen because of increases in the population. Whether these problems will continue at the same level, become more severe, or be resolved in the future is at least partially dependent on population growth trends, future population pressures, and local government planning and administration. In order to make projections of future problems and needs, present growth trends and anticipated population growth to the year 2000 were analyzed. A discussion of population growth and related projections to the year 2000 is presented in the following section preliminary to more detailed analysis of present and future problems and needs.

POPULATION PROJECTIONS

The population of Flathead County, the local impact area, grew rapidly in the past 20 years--19.7 percent from 1960 to 1970 and 15.1 percent from 1970 to 1976. Individual population forecasts indicate growth rates of 8.1 percent to 68.8 percent in each of the next 2 decades. Since the forecasts vary widely, a range was selected. High and low forecasts are based on a 1977 study by the Montana Department of Community Affairs. A medium or "most likely" forecast is from a 1978 report of the department. These forecasts for Flathead County and for the three incorporated cities of the county are presented in table 4-1.

The Flathead County Areawide Planning Organization made population projections (1978) that are higher than those selected as most likely. The organization justifies its higher estimates on the following: (1) Flathead County population increased more in the past 6 years from 1970 than it did in the previous 20 years and (2) the recent growth occurred in spite of a major recession, severe

unemployment, and energy shortage. The organization concludes that growth will continue at a relatively rapid rate unless a major depression occurs. The organization's estimates of county populations are 55,395 in 1980 and a population of 73,575 in 1990.

Table 4-1.--Population Projections for Flathead County, Montana and Its Incorporated Cities (1980-2000)

County/Cities	Projected Population 1980	1990	2000	Percent Increase 1980-1990	1990-2000
Flathead County					
Most likely1/	48,900	55,600	62,100	13.7	11.7
High2/	63,387	106,994	178,391	68.8	66.7
Low2/	42,055	46,028	49,775	9.4	8.1
Incorporated cities in Flathead County					
Columbia Falls					
Most likely1/	3,300	3,750	4,150	13.6	10.7
High2/	4,541	7,665	12,780	68.8	66.7
Low2/	3,013	3,297	3,566	9.4	8.2
Kalispell					
Most likely1/	16,150	18,350	20,500	13.6	11.7
High2/	16,629	28,070	46,801	68.8	66.7
Low2/	11,034	12,075	13,059	9.4	8.1
Whitefish					
Most likely1/	3,900	4,450	4,950	14.1	11.2
High2/	6,000	10,128	16,887	68.8	66.7
Low2/	3,982	4,357	4,712	9.4	8.1

1/ *Montana State Department of Community Affairs, 1978, page 11*
2/ *Montana State Department of Community Affairs, 1977, page 26*

The choice of the most likely projection is based on an assumption that in the future population growth will more closely parallel growth in the economic base and the opportunities for employment. The economic base is expected to continue to expand and employment opportunities will increase. This increase, however, will not support the inmigration rate that occurred during the 1970's, so the inmigration rate in the future should decline. Future economic conditions, including employment and economic base, are discussed in the following section.

ECONOMIC PROJECTIONS

The economy of Flathead County is expected to continue to grow through the year 2000. Growth in some sectors, however, will be dependent to a large extent on interest rates and other national economic factors. Such sectors include manufacturing, contract construction, finance, insurance, and real estate.

Manufacturing, particularly in the wood products industry, is expected to grow more than most other sectors. The wood products industry, which now accounts for more than half of the employment and earnings of the manufacturing sector, has good prospects for expansion of secondary product plants. This would have a positive effect on most other sectors. The Anaconda Aluminum Plant is expected to continue to have a major role in the economy. However, the contribution of the primary metals segment of the manufacturing sector will be dependent on electric power availability, technological innovations, cost of supplies, and competition from other products.

The contract construction sector will probably continue to fluctuate but grow slowly. In the near future highway and airport improvement programs may temporarily cause a surge in growth.

Growth in the finance, insurance, and real estate sector is expected to grow with the population. The wholesale and retail trade sector will probably experience similar growth. In contrast, the service sector should continue to grow strongly or expand. Growth is expected to be strongest in those segments related to tourist service.

The present trend toward increased farm size and increased demand for other land uses is expected to continue. As a result, the farmland base will probably be reduced, and the agriculture sector will not change.

Future prospects of the transportation, communication, and public utilities sector are not encouraging. The present downward trend of this sector should continue.

Anticipated trends in employment and earnings by sector are summarized in table 4-2.

Table 4-2.--Trends in Employment and Earnings by Sector for Flathead County, Montana

Sector	Employment	Earnings
Agriculture	Remain same	Slight increase
Government	Slight increase	Slight increase
Manufacturing	Slight increase	Significant increase
Construction	Slight increase	Slight increase
Transportation, communications, public utilities	Remain same	Remain same
Wholesale and retail trade	Slight increase	Remain same
Finance, insurance, real estate	Slight increase	Slight increase
Services	Slight increase	Slight increase

SOURCE: Flathead County Areawide Planning Organization, 1978b, p. 3-15

EMPLOYMENT PROJECTIONS

The total employment in Flathead County is projected to increase during the next 20 years. At the same time the portion of the population employed is also projected to increase. A basis for this projection is that unless birth rates rise or longevity rates decrease significantly, the portion of the population over 20 years of age will increase. An increase in this age group should increase the demand for goods and services and should also result in an increased number of individuals entering the labor force.

Recent socioeconomic trends also support the conclusion that a greater proportion of the population will enter the labor force. These trends include decreased disposable income, decreased productivity, and increased numbers of single parent households.

Projected employment, 1980 to 2000, for Flathead County is summarized in table 4-3. For comparison, employment figures for Western Montana, the Pacific Northwest, and the Nation are included in the table.

Table 4-3.--Projected Employment for Flathead County, Pacific Northwest, and U.S.: 1980-2000

Area	Projected Employment			Percent Increase	
	1980	1990	2000	1980-1990	1990-2000
Flathead County1/	18,500	21,650	24,2502/	17.0	12.02/
Western Montana3/	102,000	117,500	129,5002/	15.2	10.22/
Pacific Northwest4/	3,448,500	4,248,100	4,292,500	23.2	16.0
United States5/	94,547,000	104,821,000	116,324,000	10.9	11.0

1/ *U.S. Department of the Interior, 1976, p. 35 (employment by household)*
2/ *Projections end at 1995; projections from 1990 to 2000 derived by doubling the projected percent increase from 1990 to 1995*
3/ *U.S. Department of the Interior, 1976, p. 29 (employment by establishment)*
4/ *Consists of Washington, Oregon, Idaho, and Western Montana (employment by establishment); U.S. Department of the Interior, 1976, p. 29; U.S. Department of the Interior, 1979a, p. 33; U.S. Department of the Interior, 1979b, p. 37; Idaho State Department of Water Resources and Boise State University, 1978, p. 319*
5/ *U.S. Water Resources Council, 1974, p. 5 (exclude armed forces employment)*

Although total employment and employment opportunities will increase, there is little chance that the present high unemployment rate will decrease in the near future. A comparison of tables 4-1 and 4-3 indicates that the most likely population projection and the employment projection are consistent but that employment will increase at a slightly greater rate. At the same time, a greater proportion of the population will probably attempt to enter the labor force, keeping the unemployment rate high.

PROBLEMS AND NEEDS ADDRESSED IN THE STUDY

The geographic area considered in the following discussion is generally limited to the Flathead River basin or to Flathead County. However, a wider perspective is needed to adequately discuss problems of meeting the electric power demand.

Electric Power

The Pacific Northwest is unique in that approximately 80-85 percent of the electric power consumed in the region is generated by hydroelectric plants. Federal, non-Federal public, and private generation facilities operate on the same rivers and streams and use the same transmission facilities. In essence, the Pacific Northwest power generating facilities are hydraulically tied into one system which is operated as a unit.

Most of the larger power generating facilities are located at considerable distances from the population or use centers and are tied together by a transmission network. The separation of generating and load areas means that most local areas or river basins are either net importers or net exporters of electric power. To achieve efficiency in generation and power transmission a great deal of coordination is needed among the various utilities and with storage facilities located in Canada.

The Flathead basin uses more power than the existing facilities in the basin can supply, and powerloads have been increasing at an annual rate of 3.5 percent in recent years. Technically desirable hydropower sites exist in the basin, but many of these sites are located in wilderness areas, in Glacier National Park, or on streams included in the National Wild and Scenic River System. Because Federal laws limit or preclude development at these sites, development of significant additional hydroelectric power capacity is unlikely, and the basin must continue to import power to meet its needs.

Major power marketing agencies in the basin include the Bonneville Power Administration, Pacific Power and Light Company, Flathead Electric Cooperative, Lincoln Electric Cooperative, and the Bureau of Indian Affairs-Flathead Irrigation Project.

Total installed generation capacity in the Flathead basin is about 458,000 kilowatts. Table 4-4 from the Flathead level B study shows the present and projected electric power requirements of the basin.

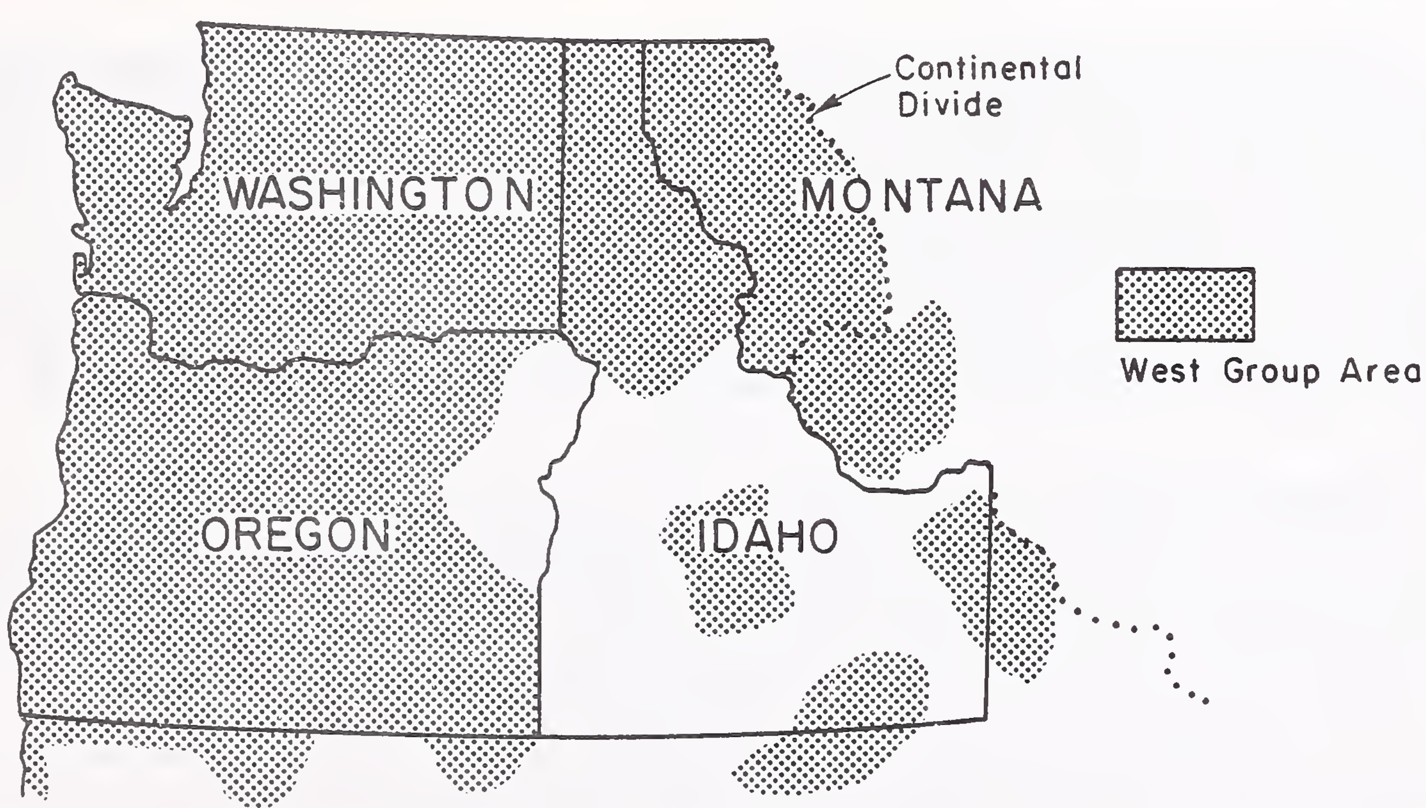
Table 4-4.--Electric Power Requirements in Flathead River Basin (1975-2020)

Electric Power	1975	1980	2000	2020
Peak (kilowatts)	535,000	595,000	1,059,000	2,564,000
Average (kilowatts)	464,000	494,000	733,000	1,508,000

Importing power to meet future loads would require upgrading transmission lines but would not be difficult if additional power is available. However, power generating capability in the rest of the Pacific Northwest is rapidly falling behind power demands.

The Pacific Northwest Utilities Conference Committee (PNUCC), a planning forum made up of utilities and power agencies in the region, has for many years made long-term forecasts for the West Group area. The West Group area includes the entire state of Washington; the panhandle of Idaho; Oregon, except for the southeastern part of the state; a small portion of northern California; Bonneville Power Administration loads in western Montana and southern Idaho; and certain other loads in western Montana. It does not include the service areas of Idaho Power Company, California-Pacific Utilities Company (eastern Oregon), Utah Power and Light Company, and the Montana Power Company. Firm contractual arrangements of West Group area utilities with utilities outside this area are included in the loads. The generalized area is shown below.

West Group Area of Northwest Power Pool



The West Group area systems include Bonneville Power Administration, Pacific Power and Light Company, Portland General Electric Company, Puget Sound Power and Light Company, Washington Water Power Company, and 115 public agency customers of BPA.

The Power Planning Committee of the Pacific Northwest River Basins Commission annually uses the PNUCC load forecast and information on present and projected electric generating capability to develop a long-range analysis of loads and generating capability. The 1980 analysis indicates that although both system loads and system generating capability are expected to increase, a net deficit in both peaking and average generating capability is projected to occur in all years from 1980 through 1999. Since projected generating capability is based on critical water conditions, additional generating capability would be available during periods of greater streamflows. Greater streamflows would partially or wholly offset the projected deficit during those periods.

To account for the variability in streamflows, the analysis includes probability projections of not meeting energy loads. These probability projections are made for a shorter period from 1980 through 1991. The probability of not meeting total energy loads varies from 36 to 79 percent for each of the years of the analysis period. Considering the total analysis period, the probability of not meeting total loads is 100 percent. The chance of not meeting firm loads is less, varying from 16 percent to 67 percent. However, a 99-percent chance exists for curtailing firm energy loads in at least 1 year between 1980 and 1991. Unlike previous short-term curtailment of hours or a few days, future energy curtailments are expected to be more lengthy, extending over months or years.

Although the analysis is the best that can be made at the present time, the data should be viewed with some caution. Various factors can either increase or decrease projected loads, and construction of new generating capability could be delayed longer than the factors assumed in preparing the analysis.

Clearly, the Pacific Northwest no longer has a surplus of generating capability to meet electric energy usage. Only by actively developing additional generating capability, reducing the rate of energy consumption, or a combination of both will the region be able to balance consumption and production of electric power.

Bonneville Power Administration markets all federally generated power in the Pacific Northwest (except that reserved for irrigation), about one-half of the Pacific Northwest total. Anticipating shortages in the near future, the BPA has notifed its preference customers that it will not be able to meet their load growth after July 1, 1983. BPA has also notified its direct service industrial customers that under present conditions, contracts which expire mostly in the mid-1980's will not be renewed. These industrial customers are primarily large electroprocess industries that account for about 57,000 direct and secondary jobs in the region.

The primary electric power need is to maintain a balance between energy use and generating capacity. This balance can probably be achieved only by a combination of development and conservation. Some conservation has already occurred and is reflected in lower projections of energy consumption than have been made in recent years. Conservation as the sole means to meet the needs is clearly inadequate and would cause hardship through loss of jobs while development alone is not practicable or generally acceptable.

The same need applies to the Flathead basin. However, the basin is likely to continue to depend on the import of power, especially considering the constraints to development within the basin. Whether the future needs of the basin can be met depends largely on whether the Pacific Northwest as a region can meet its needs.

Fish and Wildlife

In the Flathead basin fish and wildlife resources and available habitat are extensive. Hunter and angler success ratios are generally higher in the basin than in most areas of the Nation but lower than in other parts of Montana.

A major challenge facing fish and wildlife managers in the basin is preserving and, where possible, improving habitat. Degradation and loss of habitat appears to be increasing and could have a long-term effect on the area's valued fish and wildlife resources.

Although habitat loss and degradation in general are of concern, the primary challenge addressed in this study centers on fish resources, particularly kokanee. Kokanee account for approximately 85 percent of the fishery in the Flathead River system, including Flathead Lake. The vitality of this fishery is closely dependent on the water quality of the lake and river above the lake and on streamflows during spawning runs and maturation of eggs and embryos.

Power generation at Hungry Horse Dam directly affects streamflows and temperature regimes in the main stem Flathead River from the confluence of the South Fork to Flathead Lake. This stretch is a corridor in which many fish spawn and through which others must migrate to upstream spawning areas. Temperature regimes in this stretch are the opposite of that occurring in the stretch above the confluence of the South Fork. Releases from Hungry Horse Reservoir cool the main stem in the summer and warm those flows in the winter. Some fish are induced to migrate upstream at inappropriate times. When they encounter warmer or cooler water above the South Fork confluence they may become confused and return to the lake. Returning fish may not spawn successfully at a later time.

Another factor that affects fish productivity is the extreme flow fluctuation and irregular flow patterns caused in this stretch of the river by releases from Hungry Horse Dam. When possible, the fishery is considered in the operations and flows are modified accordingly. But under a variety of circumstances such as poor water years, high electric power demand, and rapid spring runoff, meeting authorized project purposes of power generation and flood protection overshadows other interests and operations can limit fish productivity. Irregular flows confuse migrating fish, alter feeding moods, and probably decrease the production of aquatic insects, the primary food supply for the fish. In addition, high flows during the spawning period induce fish to form redds (nests) at higher elevations on the streambed. During low flow periods, which may last several days, the eggs and developing embryos in these redds are exposed to the air and freeze or dry. Eggs and embryos may be destroyed in less than 30 hours when low flows occur during periods of very low air temperature.

A decrease in the maximum variation in riverflows, increased regularity of flow fluctuations with a concurrent reduction in long periods of low flows, regulation of releases from Hungry Horse Dam during spawning to improve spawning and migrating actions, or a combination of these is needed to improve and stabilize the fishery. This is especially true since the river stretch between Flathead Lake and the South Fork confluence provides about two-thirds of the habitat for maximum reproduction.

In the absence of developments considered in this study, future releases from Hungry Horse Dam should become more regular, while variation between maximum and minimum flows will probably remain unchanged. Releases are now made to produce electric power for peakloads, baseloads, and to supply power during outages at other plants. Future powerplant operations are expected to meet primarily peaking needs as more of the baseload needs are met by thermal plants in the Pacific Northwest. Flows from Hungry Horse Reservoir will then be more cyclical with few extended periods of high or low flows.

Increased regularity of flow fluctuations will partially alleviate some problems in the future, but other needs will continue to exist. These include a need to reduce the maximum variation between high and low flows and a need to regulate flows for fishery purposes during migrating and spawning times. Without satisfaction of these needs, current "good year" productivity will decline in the future.

Recreation

The present supply of recreation facilities in the basin appears to be generally adequate. However, the mix of private and public developed facilities appears to be a problem. Many private facilities appear to be unused or underused, while Federal- and state-provided facilities are generally overused. Private facilities serve an important role by supplementing recreational opportunities provided by public agencies and by providing opportunities not otherwise offered. However, a number of the commercial developments are faced with financial difficulties.

Part of this problem stems from the fact that the two types of facilities, private and public, are quite different in character. Private facilities generally are highly developed with utility hookups, hot showers, and other amenities and are usually located near major highways in developed (suburbanized) areas. In contrast, public facilities are less fully developed (pit-type toilets, no showers, and no utility hookups) but are usually located in undeveloped areas and frequently along scenic bodies of water. The two types of facilities appeal to different groups, and the group that prefers the less developed, more scenic facilities may be larger.

Another part of the problem is that private facilities vary in quality. While some private facilities are of high quality, others have not been developed or maintained in a manner compatible with the high quality of the surrounding natural environment.

Whether an increase in the total number of recreational facilities is needed in the future appears questionable. An excess of underused private facilities and a shortage of public facilities is highly probable. The question of total facility need requires intensive study of the recreation problem at a feasibility level.

Kokanee spawn in relatively shallow water where the streambed is composed primarily of small gravel-size rock. (Montana Department of Fish, Wildlife, and Parks photograph)

Kokanee eggs are placed in special bags and buried in spawning areas as part of ongoing fishery studies. The bags are checked later for development and survival of eggs and fry. (Montana Department of Fish, Wildlife, and Parks photograph)

Projections of recreation demand, supply, and net needs have been made from the limited data available. The anticipated supply of recreational facilities used in the projections is the supply that exists at the present. This assumes that any additions to the present supply, whether private or public, would be balanced by a loss in the private sector. While this assumption is speculative, a better estimate of future supply cannot be made at present.

The demand for recreation activities as shown in table 4-5 is expected to increase. For most activities, an increase in the supply of facilities is not needed or the needs are not known. An exception is picnic facilities, which will need to be increased if the demand is to be met.

Table 4-5.--Recreation Facility Demand, Supply, and Needs* in the Study Area--1980 and 2000

Activity	1980 Demand	1980 Supply	1980 Needs	2000 Demand	2000 Supply	2000 Needs
Camping (units)	1,345	2,434	(1,089)	1,886	2,434	(548)
Picnicking (units)	243	223	20	338	223	115
Swimming (lineal feet)	90	Unknown	Unknown	146	Unknown	Unknown
Sightseeing (acres)	2,018	Unknown	Unknown	2,872	Unknown	Unknown
Fishing, boating, and water-skiing (launch lanes)	15	31	(16)	21	31	(10)
Hunting (acres)	133,414	Unknown	Unknown	172,386	Unknown	Unknown
Horseback riding (miles)	1.4	Unknown	Unknown	2.0	Unknown	Unknown
Snow activities (acres)	86	Unknown	Unknown	135	Unknown	Unknown

* Needs enclosed in parentheses represent situations where supply exceeds demand.

In contrast to the county as a whole, a need for additional recreation facilities is projected at Hungry Horse Reservoir. The National Park Service has indicated that no additional overnight facilities will be constructed at Glacier National Park, although visitor use and demand is expected to increase. Out-of-park demand for nearby facilities is expected to increase as a result of the decision to not meet projected in-park demands. In addition, because of the finite mix of recreation facilities at Flathead Lake, recreationists may travel further to Hungry Horse Reservoir for recreation activities.

The projected need for increased recreation facilities at Hungry Horse Reservoir is 17 camping units by the year 2000.

In addition to other recreation problems, there are safety problems inherent in the operation of Hungry Horse Dam and Reservoir. Major problems involve submerged logs, stumps, and floating debris in the reservoir and sudden increases in water level and flows below Hungry Horse Dam. When powerplant operations begin the water rises and flows increase rapidly, changing river conditions from safe to hazardous for boaters and rafters. Fishermen who cross to islands at low flow periods could be stranded or swept downstream. Longtime residents and users of the area are generally aware of potential dangers and can take adequate precautions. However, additional signing or other measures may be needed to protect occasional visitors using the area.

OTHER PROBLEMS AND NEEDS IDENTIFIED

Irrigation

A primary problem in the basin is that approximately 127,000 acres of the 166,700 acres presently irrigated need supplemental water; shortages occur late in the irrigation season. A major cause of this situation is that much of the irrigation has been developed independently by private landowners using only the best lands and the least costly methods, which depend directly on streamflows and do not include provision for storage. As a result, irrigation storage supplies are inadequate for basin needs, and most privately developed lands do not include storage facilities to supply irrigation needs when streamflows drop and become inadequate to meet needs in the late summer and fall. This type of development has worked well in the past, and landowners have been able to resolve their problems individually. But with increased emphasis on environmental concerns and additional development of irrigation, the ability of private landowners to solve problems has been reduced. Individual land development and water diversion in an uncoordinated fashion may preclude maximum use of resources in some areas.

In an effort to alleviate some of the problems the Water and Power Resources Service, the Soil Conservation Service, and the Bureau of Indian Affairs have studied numerous proposals. Such proposals have in recent years met with little sustained public support. Interest is generally high during dry years, but with a series of wet years support falls rapidly.

High water tables on some lands in the basin reduce productivity. This problem may partially be related to the inefficient and excessive application of water. The current irrigation diversion requirement exceeds 800,000 acre-feet of water annually. An estimated 53 percent of this diversion is return flow.

In the future problems are likely to intensify. Two sets of projections for new irrigation development in the basin are available. The first set, prepared by the Pacific Northwest River Basins Commission, is based on OBERS1/ Series C, which reflects a nationally uniform procedure for estimating demands for food and fiber by state. These projections were disaggregated from the state total for the Flathead River basin estimate. The alternative set of projections, prepared by the State of Montana, Department of Natural Resources and Conservation, is based on projected statewide red meat production. The Montana State projections assume a much higher growth in irrigation as shown in table 4-6.

1/ Derived from OBE, Office of Business and Economics, and ERS, Economic Research Service

Table 4-6.--Projected New Irrigation in the Flathead River Basin, 1970-2020 (acres)

Projection	1970-80	1980-2000	2000-20	Total
Series C	14,000	4,000	6,000	24,000
Montana alternative	9,800	19,600	19,600	49,000

With additional development, problems involving tribal and nontribal water rights within the Flathead Indian Reservation will increase. Although state law requires adjudication of all water rights and the Confederated Tribes are planning an inventory of water use on the reservation, schedules for accomplishment have not been set. Conflicts over water rights are expected to increase until water rights have been adjudicated.

In the present as well as in the future, coordination of irrigation development is needed to avoid precluding the use of some resources. Problems associated with late season water shortages need to be addressed by development of additional storage, increasing the efficiency of water use, or by other suitable methods. Water right questions in the basin need to be resolved.

Municipal and Industrial Water

Although water for domestic use is generally available throughout the basin, present development of supplies in some communities is inadequate. The major problems for communities in the Hungry Horse area are poor water quality, unreliability of delivery systems, and inadequate storage of water for peak use periods or for emergencies.

Approximately 49 percent of the population in Flathead and Lake Counties is now served by municipal supplies. The remainder of the population is served primarily by individual systems. However, the population of urban areas is expected to increase much more rapidly than the population of rural areas. The percentage of the population expected to be served by municipal systems will increase to 55 percent in 2000 and to 60 percent in 2020.

Projections of water use have been made for the years 2000 and 2020 (table 4-7). These projections indicate that municipal use will increase by about 50 percent in the next 20 years and by another 50 percent in the succeeding 20 years. Economic projections indicate that industry will grow in the future, and with that growth industrial use of water should increase. However, figures on industrial water use are not included in the projections because of the difficulty in estimating how much additional water will be needed for industry in the future.

Table 4-7.--Projected Domestic, Livestock, and Industrial Water Use, Flathead River Basin
(million gallons per day)

Use	1970	1980	2000	2020
Municipal	7.1	8.5	12.5	18.5
Rural domestic	2.8	3.2	5.1	7.1
Livestock	1.2	1.4	1.7	1.9
Industry	4.7	(Not shown because growth is too variable)		
Total	15.8			

SOURCE: Flathead River Basin, Level B Study; September 1976; State Study Team, Montana Department of Natural Resources and Conservation and Pacific Northwest River Basins Commission

In view of the present problems and the projected growth in water use, the primary present and future need is to improve present delivery systems. Specific needs vary with individual communities and include expansion of delivery systems, replacement of wornout or leaking systems with systems of greater capacity, increase in storage facilities, and improvement or addition of water treatment facilities. A particular need is that communities should be aware of anticipated population growth and to consider that projected growth when repairs to existing systems are undertaken.

Flooding

Flooding of agricultural and other lands occurs in the basin. The following contribute to flood damage: inadequate control of riverflows, erosion of streambanks, and unregulated development in flood plains. Releases from Hungry Horse Reservoir at certain times during the winter also contribute to local flooding when log and ice jams form. Releases early in the winter help prevent flood damage by maintaining an open channel.

Flood damages have recently occurred along the Flathead River between Columbia Falls and Kalispell and in the Swan River drainage, particularly near Big Fork. Flooding above Swan Lake is generally desirable to maintain wetland conditions in the Swan River National Wildlife Refuge and is not considered a problem.

Both structural and nonstructural measures have been proposed to alleviate flooding problems and flood damage. With implementation, flood damages could be decreased and agricultural productivity increased. Whether any of the proposed measures will be implemented is unclear; however, encroachment on the Flathead River flood plain will probably continue for some time, and flood damage costs will increase.

The need at present and in the future is to develop and enforce an adequate flood plain management program.

Air, Land, and Water Quality

Air, land, and water quality of the basin is generally good. However, some localized degradation of quality has occurred and is a persistent problem.

The Anaconda Aluminum Plant, north of Columbia Falls, has produced high fluoride emissions. Fluorides lower the air quality and contaminate nearby soil, water, and vegetation. Since high fluoride levels have the potential to cause bones and teeth to become brittle and break easily, the lifespan of big game animals feeding on the contaminated vegetation may be shortened.

Fortunately, this problem appears solved. An emission control system using advanced technology has been recently installed at the aluminum plant. Since the beginning of 1980 fluoride emissions have been reduced to acceptable levels (within the maximum level allowed by state air quality regulations).

The major land quality problem is erosion that results from the use of timber and agricultural resources. Inappropriate practices during logging, grazing, or other agricultural operations in some localized areas have led to degradation of land quality. Inadequate drainage facilities and flood control measures in the basin also contribute to reduced land quality.

Although the overall land quality is good at present, the potential for increased degradation will increase in the future as resources are more intensively developed. The primary need for the present and the future is to develop adequate controls and appropriate practices to maintain the quality of the land.

Some degradation of water quality has occurred in the lakes and streams of the basin. These problems are generally localized and associated with municipal and residential wastes, logging and agricultural practices, residential land use, and operation of Hungry Horse Dam. Although the three major cities in the basin have secondary treatment facilities, operation problems at two cities prevent consistent compliance with water quality standards. Most other sewage disposal facilities in the basin do not meet secondary treatment requirements. Inadequate treatment and control of sewage disposal may contribute to undesirable nutrient increase in Flathead Lake.

Operation of Hungry Horse Dam fluctuates the temperature of the main stem Flathead River in a manner that is the opposite of natural conditions. Water in the lower levels of Hungry Horse Reservoir remains essentially at a constant temperature throughout the year. Release of this water cools the main stem in the summer and warms the main stem flows in the winter.

A challenge for the future is to maintain and, where possible, increase water quality. Population increase, construction activities, and development of oil, gas, and coal resources will require concentrated attention to water quality maintenance.

Visual Quality

Visual quality throughout the area is generally high, but some local areas have problems. A seasonal problem exists at Hungry Horse Reservoir during the late fall through early spring. During this time the reservoir is drafted exposing stumps and mudflats. Improvement in visual quality during this period is unlikely as a remedy would probably conflict with the primary purpose of the project.

Another visual quality problem exists along the banks of the main stem Flathead River. Car bodies were once placed along the bank to decrease erosion and maintain bank integrity. These car bodies are generally unsightly and probably no longer serve their original purpose along the bank. Visual quality would be enhanced if the car bodies were removed.

Economic and Social

High annual and seasonal unemployment in Flathead County is a problem that has existed for some time and that will probably continue to be unresolved in the future. Seasonal unemployment reflects the county economic base of agriculture, timber industry, and tourism. In recent years annual unemployment has been 7-9 percent and seasonal unemployment has been 12-14 percent. In contrast, Montana statewide average annual unemployment rate is about 6 percent.

Factors which contribute to the high unemployment rates include (1) the status of the national economy, (2) the seasonal nature of major sectors of the economy, (3) recent growth in secondary family workers, and (4) migration of unemployed workers into the county.

Personal income growth has generally been strong but with significant fluctuations in some sectors. Farm income has fluctuated but has generally declined since 1950. This downward trend reflects a decrease in the number of farms and the number of acres being farmed in the county.

Other changes in land use have also occurred. The forest land base is decreasing significantly. Inefficient use of trees and logs and an imbalance between type and size of mills compounds the problems. Residential use, especially for subdivisions, has increased with population growth. Land management programs need to be prepared to address problems caused by the rapid and dramatic changes in land use.

The rapid population growth in the 1970's brought several problems including inadequate housing, inadequate county law enforcement and fire protection, and stressed schools. The supply of housing is generally adequate to meet most of the needs, but some housing is substandard. School districts, however, have not always been able to meet all demands.

The problems associated with increased population require both immediate action and consideration of future population pressures if the problems are to be resolved. Additional school facilities, housing, and larger law enforcement and fire protection departments are needed. Funding to meet the needs may require some state or Federal assistance.

E V A L U A T I O N   O F   R E S O U R C E   C A P A B I L I T Y

RESOURCE CAPABILITY

Resource capability was evaluated to determine the opportunities for developing the resource inventoried. A prime consideration in this assessment was not only the physical quantity of resources but the constraints and availablility of the resources for development.

Water Rights

Hungry Horse Project

The Hungry Horse Project has an associated water right to store 3.5 million acre-feet of water. The water right entity is the United States, and the priority date is June 6, 1947. Uses of this water right include power, flood control, and navigation.

Indian

The Salish and Kootenai Indian Tribes claim a right to all water that arises upon, passes through, or borders the Flathead Indian Reservation. Since this claim applies to most water in the Flathead basin, the availability of water will remain unclear until Indian entitlements and legal questions surrounding Indian water rights have been settled. An inventory of water use on the reservation, which is needed before Indian entitlements can be established, is not underway at present. Existing water uses could be impacted when tribal water entitlements are determined.

Hydropower

Several potential hydroelectric power sites on the North and Middle Forks of the Flathead River have been identified in past studies. The North and Middle Forks have since been incorporated into the National Wild and Scenic Rivers System, precluding development on these stretches of the Flathead River.

Other potential hydroelectric sites have been identified below Flathead Lake. Development of some of these sites may not meet public acceptability. The opportunities for developing hydrogeneration at new sites in the basin appear to be severely limited.

Additional hydrogeneration potential at Hungry Horse Dam has been identified. Most of the water on the South Fork now passes through the generators, so the potential is primarily related to possible increases in peak generation. Since there is potential for degradation of the existing kokanee fishery through hydropower expansion at Hungry Horse Dam, preservation of the fishery would be a primary constraint to additional power development at the Hungry Horse Project.

Fish and Wildlife

Habitat for fish and wildlife is abundant; however, care is needed in the management of forest and range resources if fish and wildlife habitat are to be preserved or enhanced. The Flathead Lake-River fishery could be improved by reducing forest soil erosion and enhancing streamflows. An opportunity exists at Hungry Horse Dam to improve flows in the South Fork and main stem for fishery maintenance and enhancement. Flathead Lake appears capabable of supporting a much increased fishery; however, additional study is needed to assess the most desirable level. Coordinated actions by county, state, and Federal agencies are necessary to identify conflicting uses and assess actual potentials for improving fish and wildlife habitat.

Water Quality

Although water quality is generally high throughout the basin, some deterioration has occurred and will continue to increase unless appropriate actions are taken. The primary opportunities for maintaining or increasing water quality include improving municipal, industrial, and domestic waste disposal systems throughout the basin and reducing erosion and runoff from forest and agricultural lands. The potential for improving the water temperature regime in the South Fork and main stem Flathead River by installing a multilevel outlet at Hungry Horse Dam is assessed in this study.

Municipal and Industrial Water

Although industrial water needs for the future are not known with certainty, resource capability appears adequate for any possible future municipal and industrial usage. Ground and surface water supplies are generally adequate although not sufficiently developed. Large-scale water storage development is generally inappropriate as most needs relate to water quality, inadequate purification or treatment of domestic supplies, undersized delivery systems, and unreliable distribution systems. Where additional or alternate water supplies are needed, small-scale open air storage, municipal tank storage, and ground water development appear to be more appropriate in view of the relatively low population density.

Recreation

Outdoor recreation resources are so abundant in the Flathead River basin that there is little question that with development these resources are capable of meeting any projected need. Although a general need for additional recreation development is not indicated, some site-specific public development may be needed. Glacier National Park is limiting additional development to protect the quality of in-park recreational experiences, and this action will create some

need for development outside the park to handle overflow. One campground in the park was closed in 1980 as a result of management decisions. Opportunities for recreational development to handle this projected need exist in nearby areas, including Hungry Horse Reservoir.

Irrigation

Resources required for successful irrigation development are a continuous water supply, arable lands, and a favorable climate. The Flathead River basin is endowed with large quantities of water and a considerable area of arable land, but the growing season is short in most areas except near Flathead Lake. Past irrigation development has taken advantage of the most favorable lands, leaving undeveloped those lands that have a less favorable climate or poorer access to water supplies. Past studies have indicated that new irrigation development may not be economically feasible in many areas because the short growing season limits cropping patterns, and water distribution system costs are high. An additional problem is that over three-fourths of the presently irrigated lands suffer late season water shortages, indicating that present storage is insufficient. Future irrigation development would require additional storage, but suitable sites are limited and development of some of these sites would conflict with fish and wildlife interests.

A situation that makes an assessment of irrigation potentials difficult is the unresolved status of Indian rights to water as discussed previously. Considering the future availability of water, constraints to storage development, and past indications of the economics of development, opportunities for developing new irrigation in the basin appear to be severely limited.

CONSTRAINTS

The primary purpose and emphasis of this investigation was originally defined as an assessment of undeveloped hydroelectric power potential at the existing Hungry Horse Dam. The planning team (see "Planning Criteria and Standards" section) adopted the formulation constraint that any alternative must include a power function.

After a review of problems and needs and resource capability within the general area, the planning team adopted the constraint that development would be considered only in the Hungry Horse Project area. This constraint was adopted because resource capability for power production is limited by several constraints and development of large-scale facilities for other needs is unnecessary or limited by economic considerations. A second consideration is that the issue of Indian water rights is unsettled and the availability of water for consumptive uses cannot be accurately evaluated at present.

The Montana Department of Fish, Wildlife, and Parks indicated that maintenance or enhancement of the kokanee fishery in the upper Flathead River system should be a primary consideration in formulating plans. Local residents, Federal fishery agencies, and other state and Federal agencies indicated that any plan that would have an adverse impact on the fishery would be unacceptable. The team adopted the constraint that plans should not adversely affect the fishery.

The three constraints mentioned above and other constraints recognized during formulation are summarized in table 5-1.

Table 5-1.--Formulation Criteria

Item	Constraint
Development area	Limit facilities to the existing Hungry Horse Project area and adjacent lands
Power	Include a power function in all alternatives
Fish and wildlife	Formulate plans to at least maintain the present kokanee fishery
Environment	Formulate plans that are compatible with recognized environmental quality objectives for the area
Economics	Project benefits should equal or exceed costs and reimbursement of project costs should be possible in the prescribed time period

SUMMARY OF SPECIFIC STUDY OBJECTIVES

After completion of the resource inventory and assessment of resource capability, the study team selected specific needs and measures that could be addressed. The selection process involved identifying potential measures to alleviate problems and needs identified earlier and evaluating these measures in terms of resource capability, constraints, and past economic findings. The selected measures were then related to the components of the two major objectives--national economic development and environmental quality. The resulting components are the specific objectives shown in table 5-2.

As a result of the selection process several problems and needs were eliminated from further consideration. These include (1) late season irrigation shortages, (2) new irrigation development, (3) flood control, (4) municipal and industrial water supplies, and (5) water quality needs. The reasons for elimination include economic justification is unlikely as shown in past studies and enforcement or improvement of existing programs offer some solutions.

Table 5-2.--Specific Objectives

Major Objective and Component	Specific Objective	Problem or Need
National economic development		
Hydropower	Increase hydropower generation at Hungry Horse Dam	Basin imports more power than it generates; accute shortage of electric power in Pacific Northwest is predicted
Recreation	Increase recreation opportunities at Hungry Horse Dam and Reservoir	Overflow from Glacier National Park will create a need for more facilities in nearby areas
Fish and wildlife	Maintain or increase fishing opportunities on Flathead River-Lake system	Kokanee fishery is limited by fluctuating flows caused by power generation at Hungry Horse Powerplant
Environmental quality		
Ecological systems	Maintain or enhance the Flathead Lake-River ecosystem	Fluctuating flows caused by power generation at Hungry Horse Powerplant limit fish and other aquatic organism production

PLAN IDENTIFICATION AND EVALUATION

The plan identification process resulted in the preliminary formulation of several hydropower expansion plans. One of the most promising of these plans, the Outlet Power plan, is discussed in this chapter to demonstrate the potential for additional hydropower development at the Hungry Horse site. On the basis of these preliminary findings, detailed studies of hydropower additions are warranted. Congress in Public Law 96-375, October 3, 1980, provided authority for detailed feasibility studies. When funds for the study are made available the plan formulation and evaluation process will be done in depth. This could alter the findings and conclusions discussed here.

OUTLET POWER PLAN

The Outlet Power plan emphasizes economic development through increased hydropower generation, increased fishing opportunities, and increased recreational opportunities. An environmental objective is provided through reduction of flow fluctuation in the main stem Flathead River (from the South Fork confluence downstream to Flathead Lake).

The plan includes constructing a 51-foot-high reregulating dam about 3.4 miles downstream from the existing Hungry Horse Dam (see Facilities Location and Reregulating Dam and Reservoir maps). The reregulating reservoir would have a maximum storage capacity of 1,950 acre-feet. Also included is expansion of the existing Lid Creek Campground on the west shore of Hungry Horse Reservoir from 22 to 39 units.

The plan would add a new 55,000-kilowatt powerplant at the existing outlet works of Hungry Horse Dam, which when combined with the present 285,000-kilowatt plant would increase capacity at the Hungry Horse site to 340,000 kilowatts.

Function

Power

Instantaneous peaking capability, average annual energy generation, and dependable capacity would be increased above the existing capability with the plan. In addition, the plan would result in a fossil fuel saving compared with an alternate thermal plant capable of generating equal amounts of electric power.

The plan would not only increase the power yield beyond existing capability but would also add flexibility to operations. The hydraulic capacity of the outlet works is sufficient to allow a flow of 1,950 ft^3/s at a rated head of 398 feet to generate an additional 55,000 kilowatts, a 16.8-percent increase in peaking capability. Total hydraulic capacity for generation would be increased from about 11,420 ft^3/s to 13,370 ft^3/s. If a maintenance period

of the existing generators occurs during a critically low flow period, spill through the outlet would be necessary to meet downstream demands. With the addition of a powerplant at the outlet works any necessary spills would be used to generate power. As a result, average annual generation would be increased 10.4 percent, and dependable capacity would be increased 42.5 percent.

A fossil fuel savings would be realized. This savings is based on the amount of fuel that would be used by a thermal plant that could supply the additional power capacity and type of power provided by the Outlet Power plan. The annual savings has been calculated in barrels of #2 distillate fuel, the type of fuel a comparable thermal alternative would use. The Outlet Power alternative would save the equivalent of about 160,000 barrels of oil per year.

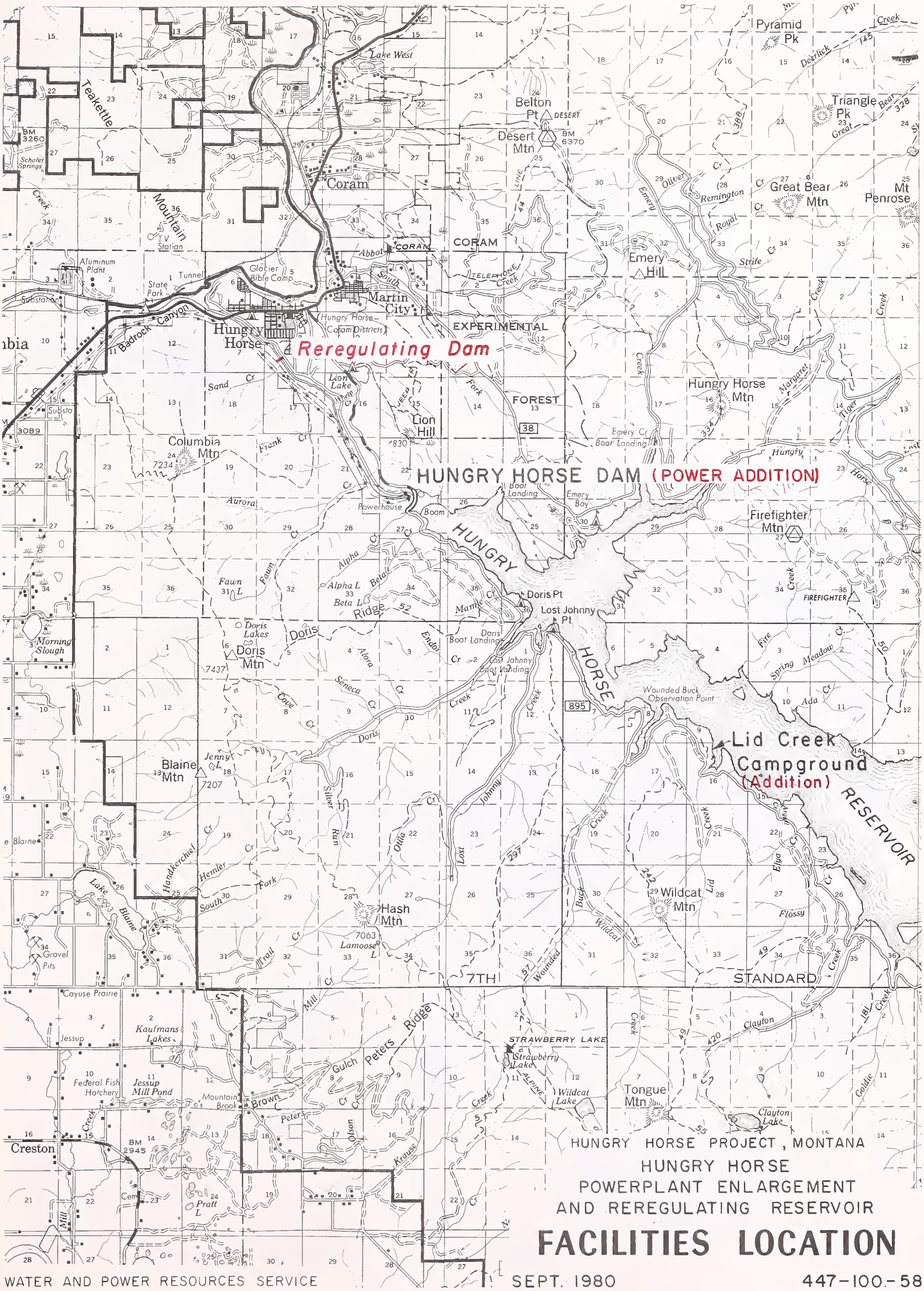
The plan would reduce the 1990-91 average annual firm energy shortfall by 6.0 percent.

Power yields and other power functions for the existing powerplant and for the Outlet Power plan are shown in table 6-1. The figures given in the table are averages based on 39 years of historical flows (1929-67) and the 42-1/2-month critical period of low flows in the Pacific Northwest (August 15, 1928-January 1932).

Table 6-1.--Power Yields and Functions of the Outlet Power Plan

Item	Existing	Outlet Power	Difference
Installed capacity (kilowatts)			
Nameplate rating	285,000	340,000	55,000
Dependable capacity (kilowatts)	247,000	352,000	105,000
Average annual energy (kilowatt-hours)			
Peak	448,059,500	502,727,600	54,668,100
Other	392,900,500	424,956,400	32,055,900
Total annual energy	840,960,000	927,684,000	86,724,000
Plant factor (percent)1/	29	28	-1
Capacity factor (percent)2/	39	30	-9
Annual fuel saving potential of additions (barrels of #2 distillate fuel oil needed for alternate thermal plant)	--	160,000	160,000

1/ *Total average annual energy compared to total energy obtainable if plant were operated full time at actual installed capacity*
2/ *Total average annual energy compared to total energy obtainable if plant were operated full time at dependable capacity*



HUNGRY HORSE PROJECT, MONTANA

HUNGRY HORSE

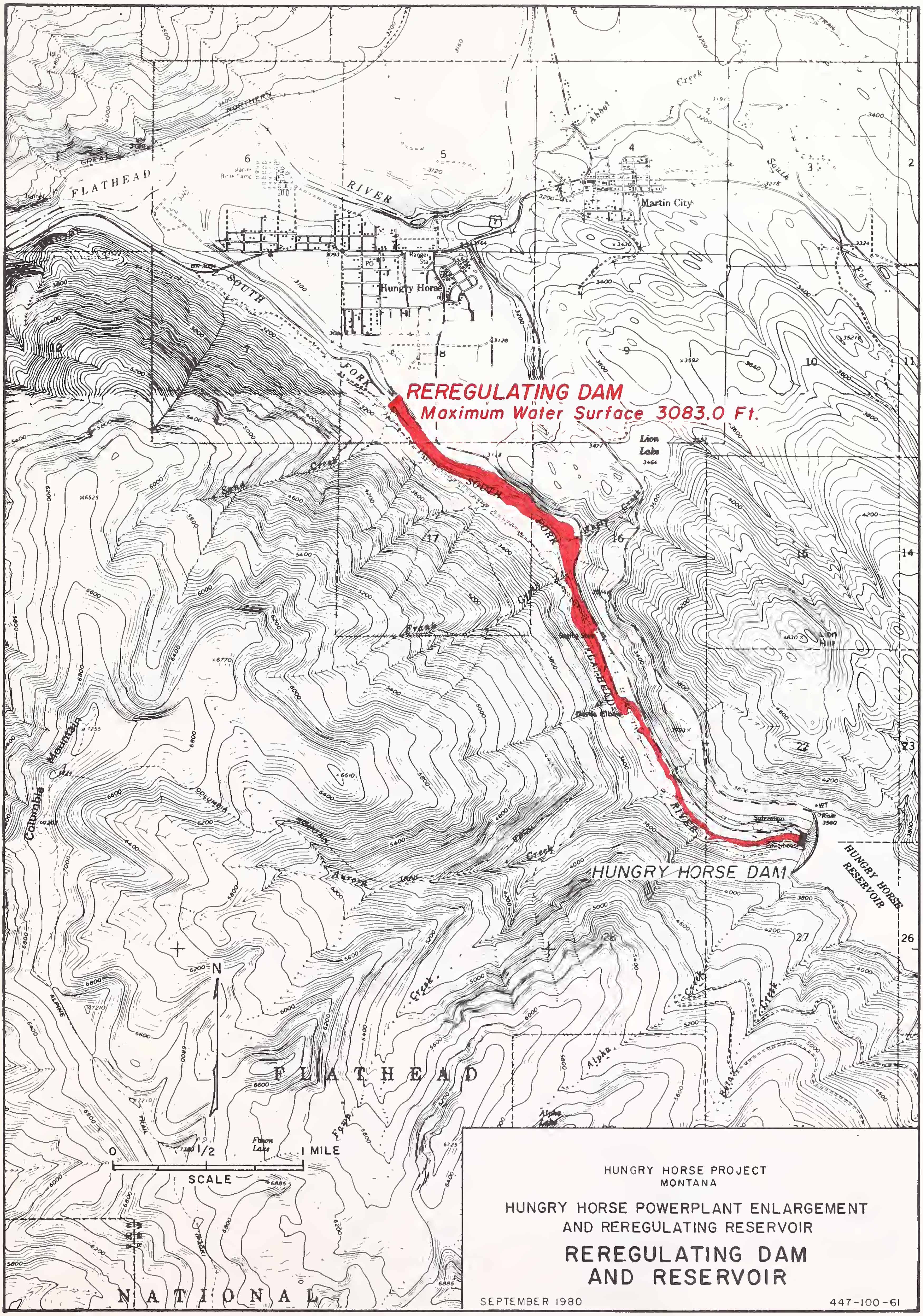
POWERPLANT ENLARGEMENT AND REREGULATING RESERVOIR

FACILITIES LOCATION

WATER AND POWER RESOURCES SERVICE

SEPT. 1980

447-100-58



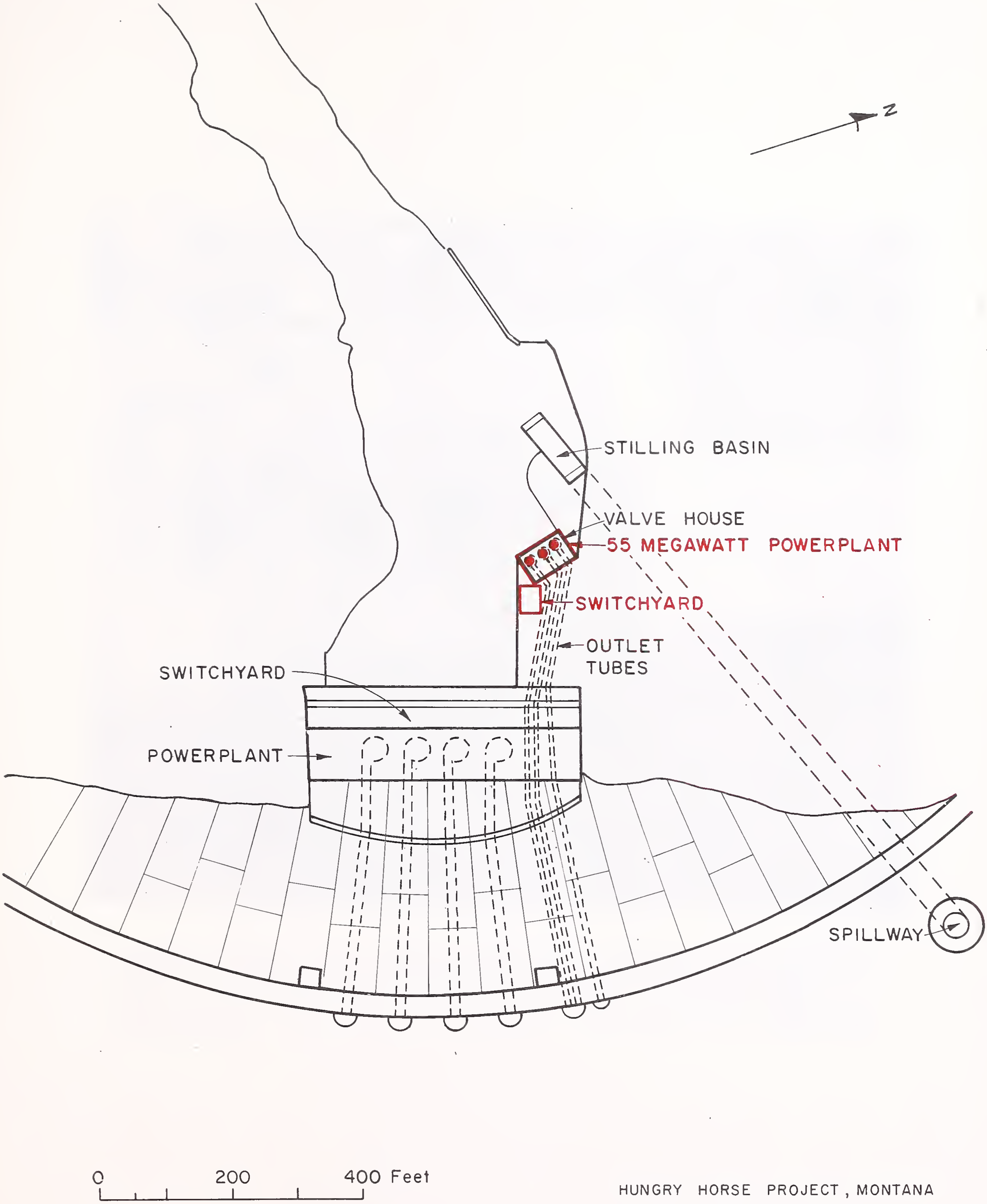
HUNGRY HORSE PROJECT
MONTANA

HUNGRY HORSE POWERPLANT ENLARGEMENT
AND REREGULATING RESERVOIR

REREGULATING DAM AND RESERVOIR

SEPTEMBER 1980

447-100-61



HUNGRY HORSE PROJECT, MONTANA

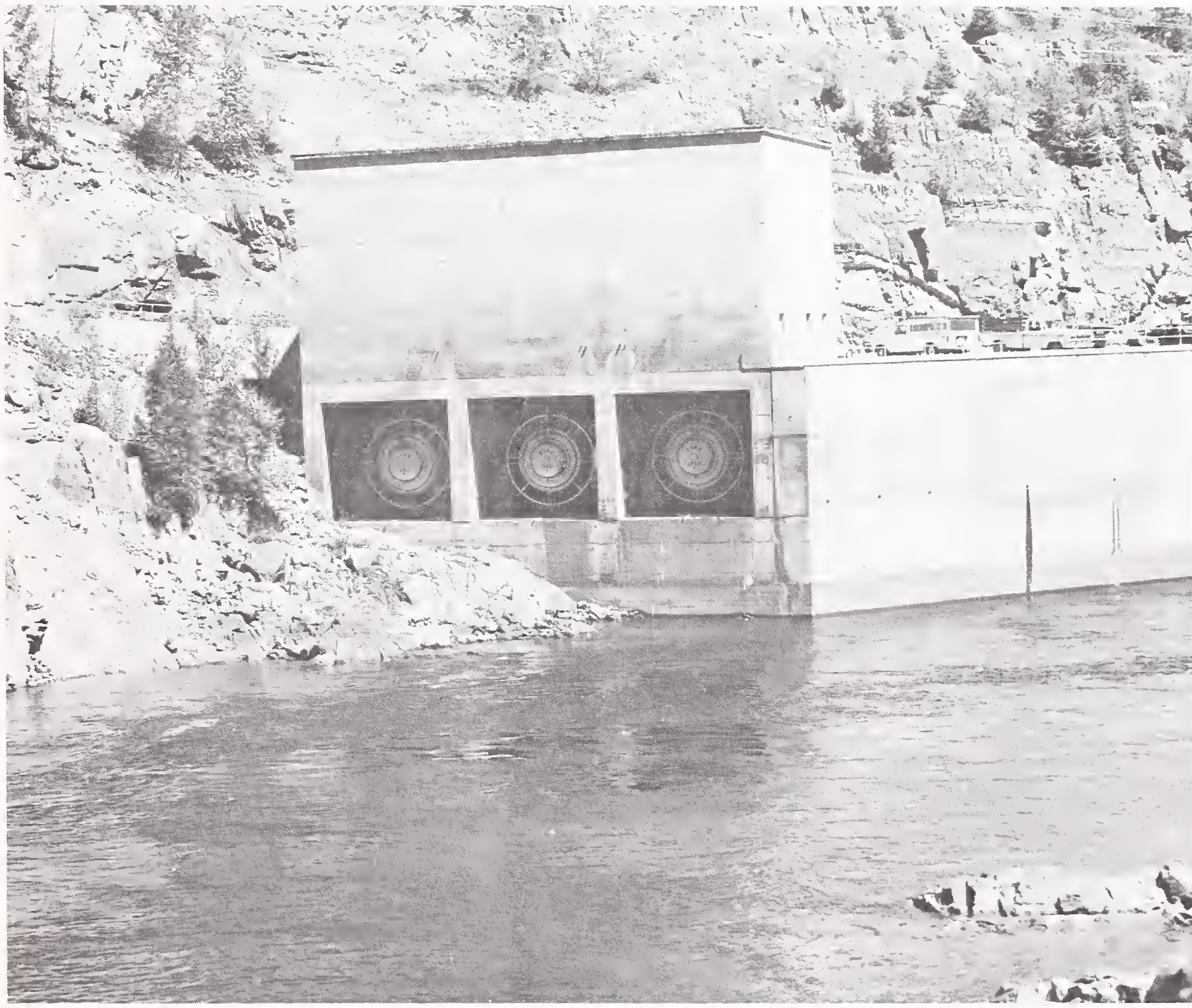
HUNGRY HORSE
POWERPLANT ENLARGEMENT
AND REREGULATING RESERVOIR

POWER FACILITIES

WATER AND POWER RESOURCES SERVICE

SEPT. 1980

447-100-60



The valve house, located just downstream from Hungry Horse Dam, is a concrete structure that contains the outlet works control mechanisms. With the Outlet Power plan the valve house would be modified and converted to a 55,000-kilowatt powerplant containing three generators. (P447-100-265)

Fish and Wildlife

The Outlet Power plan would increase the productivity of the Flathead River-Lake fishery. Enhancement would consist primarily of providing increased fishing opportunities by reducing winter loss of kokanee eggs. The reregulating reservoir would function to reduce maximum flows during short periods of generation at Hungry Horse Powerplant and to extend the period of above-minimum flows when the powerplant stops generating power. At the beginning of a generation cycle a portion of the power flows would be stored in the reregulating reservoir until the reservoir is filled. At the end of the cycle flows would be released from the reregulating reservoir to reduce the period of minimum flows before the next power generating cycle begins.

A minimum flow in the South Fork below Hungry Horse Dam, established in cooperation with the Montana Department of Fish, Wildlife, and Parks, is 145 ft^3/s. The Department has stated that a minimum flow of 500 ft^3/s would benefit the downstream fishery. Hydrologic studies indicate that under projected power operation modes the reregulating reservoir could be operated so that flows in the South Fork below the reregulating pool would normally exceed 500 ft^3/s during periods critical to fish egg incubation and larvae maturation. If information from fishery studies now underway indicates a substantial benefit, setting a higher minimum flow in the South Fork would be considered during more detailed feasibility studies.

Under present conditions, extended periods of minimum flows from the South Fork (no power generation at Hungry Horse Powerplant) result in lowered water levels and exposure of kokanee spawning beds in the main stem. If these periods extend for much more than 3 days, which occurs at present, developing kokanee eggs in the exposed redds can be killed. Because of the small size, the reregulating reservoir would have little modifying effect under these conditions. However, the generating schedule at Hungry Horse Powerplant is expected to become much more cyclical in the future with shorter periods of power generation alternating with shorter periods of minimum flows (no generation). In this case, the reregulating reservoir will have the capacity much of the time to provide flows to protect developing kokanee eggs in the main stem.

Reduction in the periods of minimum and maximum flow in the South Fork would have a significant effect on water levels in the main stem Flathead River. The plan would reduce average water level changes and the amount of substrate exposed during October when most kokanee spawn and during the winter when eggs are incubating. Table 6-2 shows an estimate of water level changes and substrate exposure at the Geological Survey gaging station located at Columbia Falls. Since the gaging station is located in a fairly narrow and deep reach of the river, substrate exposure would be greater in shallower areas where kokanee normally spawn.

Table 6-2.--Estimated Water Level Fluctuation and Substrate Exposure at Geological Survey Gaging Station, Columbia Falls (Main Stem Flathead River)1/

	Water Level Change (feet)				Substrate Exposed (feet)2/			
	Average		Maximum		Average		Maximum	
Alternative	October	January	October	January	October	January	October	January
No Action	2.1	2.6	4.4	4.9	22	31	57	61
Outlet Power	1.0	1.4	4.0	4.9	10	14	50	61

1/ Estimates are based on daily changes for the No Action alternative and on weekly changes for the Outlet Power plan.
2/ Linear measurement of river bottom profile

Kokanee productivity would increase in both good and poor productivity years which occur in equal proportion at present. Low productive years appear to be directly related to destruction of kokanee eggs in the main stem spawning beds when extended periods of no generation at Hungry Horse Powerplant during winter months cause a drop in the water levels of the main stem Flathead River. High productivity occurs in years that water supplies are above average or whenever generating flows at Hungry Horse Powerplant are not interrupted for extended periods. This pattern of good and poor productivity years will continue in the future with or without the plan because water supplies and power generation to a large extent are related to the climate. However, with the plan good year productivity will be about double, and poor year productivity will be more than double compared to no development. Anticipated increases in productivity and fishing opportunities in Flathead Lake and the upper Flathead River attributable to the Outlet Power plan are shown in table 6-3, expressed in fisherman satisfaction units (FSU). These units, explained in the "Planning Criteria and Standards" section, are essentially a value judgment of the Montana Department of Fish, Wildlife, and Parks based on fish species, length, and for kokanee, whether river or lake caught.

Table 6-3.--Annual Fisherman Satisfaction with the Outlet Power Plan Expressed in Fisherman Satisfaction Units

General Fishing Condition	No Action	Outlet Power	Increase with Outlet Power
Good years (FSU)	359,614	825,240	465,626
Poor years (FSU)	190,250	527,916	337,666

A loss of the existing fishery in the 3.4-mile-long reregulating reservoir portion of the South Fork Flathead River is projected. The Montana Department of Fish, Wildlife, and Parks projects water level fluctuations would be so severe that fish could not survive in this portion of the river. This loss was not calculated since the present fishery is so small that any loss would be insignificant.

Macroinvertebrates, mainly immature stages of aquatic insects, are an important food source for fish that would be affected by development. The immature stages live in the space between gravel particles in the bottom of streams, are relatively immobile, and cannot tolerate long drying periods. The Outlet Power plan would reduce flow fluctuations, increase the permanently wetted river bottom area, and improve macroinvertebrate productivity in the main stem Flathead River.

An improvement in macroinvertebrate populations in the South Fork below Hungry Horse Dam is not expected. Maximum and minimum flows and river bottom exposure are expected to be nearly identical with or without development of the plan.

The reregulating dam would be located in this stretch of the South Fork Flathead River. (P447-100-254)

The valley of the South Fork widens downstream from the reregulating damsite. (P447-100-253)

A small increase in suitable wildlife habitat and riverine wildlife populations is anticipated. Modification of power flows by the reregulating reservoir would slightly improve the stability of ecological systems along the downstream riverbanks. Furbearers such as muskrats and beaver would probably benefit most. Beneficial effects on wildlife have not been quantified at this preliminary level of study.

The reregulating reservoir could disrupt elk migration routes through the area. The effect is expected to be slight as the reservoir is small and elk could easily detour around the reservoir.

Recreation

The recreation component consists of enlarging the existing Lid Creek facility from 22 to 39 overnight camping units. This expansion would provide an increase in recreational opportunities in the area. Visitor usage attributable to the expansion is expected to increase during the first 11 years of the project and remain at a level of 4,444 visitor-days annually after project year 11. Some usage is expected by Glacier National Park visitors who cannot find other accommodations or who prefer a less crowded setting.

The Outlet Power plan would provide a beneficial safety aspect downstream from the reregulating reservoir. The reregulating dam would reduce the rate that water levels rise in the South Fork and main stem Flathead River when a power generation cycle begins. This would significantly reduce the existing hazard for fishermen and other river users.

Adverse effects include a minor loss of revenue to private campground operators and a minor loss of recreation use of the reregulating reservoir stretch of the South Fork. Some recreationists may use the camping facilities provided instead of camping at private campgrounds. The small amount of kayaking and rafting that occurs on the South Fork below Hungry Horse Dam would be restricted to the river stretch below the reregulating dam.

Environmental Quality

Construction of the reregulating reservoir and dam would reduce riverflow fluctuation, enhancing the habitat for fish and other aquatic organisms. Ecological systems, aquatic or riverine in nature, would be slightly more stable. With decreased flow fluctuations and reduced periods of low flows the visual quality of the downstream river would improve slightly. Visual quality of the reregulating reservoir portion of the South Fork Flathead River would probably decrease slightly.

Reduced fluctuations would probably permit better access for fishermen and other recreationists along portions of the main stem Flathead River.

Although a class I cultural resources survey indicates that the presence of cultural resources is unlikely, a class II survey (field investigation) and, if appropriate, a class III survey (intensive on-the-ground investigation) of the reregulating dam and reservoir site would be made during more detailed

feasibility studies. Any resources found would be identified or inventoried and evaluated for significance. Salvage, detailed recording, mapping, or other appropriate mitigation would be carried out if cultural resources are found.

Facilities

Power

A reregulating dam would be constructed approximately 3.4 miles downstream from Hungry Horse Dam. The dam would be an earthfill structure faced with suitable riprap material and would have a crest length of about 321 feet and a crest width of about 22 feet. The crest elevation would be at 3090 feet, about 51 feet above the streambed of the South Fork Flathead River. The upstream slope of the dam would be 2.5:1, and the downstream slope would be 3:1.

A concrete spillway with a design capacity of 76,500 ft^3/s, the maximum discharge expected from Hungry Horse Dam, is included in the reregulating dam design. The spillway would be 111 feet wide with a crest elevation at 3039 feet, the elevation of the streambed. Control would be achieved by three 40-foot by 33-foot radial gates set at elevation 3039 feet. The spillway would serve the dual function of controlling releases from the reregulating reservoir and also serve as the outlet works.

The reregulating reservoir would have a maximum capacity of 1,950 acre-feet and a maximum surface acreage of 88 acres at elevation 3083.0 feet. When the reregulating reservoir is full, approximately 3.4 miles of the South Fork Flathead River upstream to Hungry Horse Dam would be inundated. Since all of the storage is active, the reregulated portion of the South Fork would be free flowing at minimum pool elevation.

A preliminary review of the site selected for the reregulating dam indicates that the geologic aspects of the site and the supply of nearby materials for constructing the dam are adequate. Executive Orders 11990 (Protection of Wetlands) and 11988 (Floodplain Management), which provide regulations for avoiding impacts and direct or indirect support of flood-plain development, were followed. The reregulating dam must be constructed in the 500-year flood plain but would be designed and constructed so that minimal or no damage would occur in the event of a 500-year flood level. Acquisition of right-of-way for constructing the reregulating dam is not needed. Land on the northeast side of the river is under withdrawal by the Water and Power Resources Service, and land on the southwest side is national forestland.

The Outlet Power plan, in addition to the reregulating dam, would require modification of the existing outlet tubes, modification of the existing valve house, and construction of a new switchyard. The three existing 8-foot-diameter outlet tubes would be modified with bypass valves for use as penstocks and continued use as the outlet works of Hungry Horse Dam. The existing valve

Facilities at the existing Lid Creek Campground include a boat ramp (P447-100-257)

Camping units at Lid Creek provide solitude and easy access to Hungry Horse Reservoir. The number of overnight camping units would be expanded from 22 to 39. (P447-100-262)

house is an indoor plant with a reinforced concrete superstructure. This structure would be modified to house three equal-sized generating units driven by Francis turbines. Total installed capacity would be 55,000 kilowatts. Discharge through the three units would total 1,950 ft^3/s at a rated head of 398 feet. A new switchyard consisting of a new building, circuit breakers, switches, buswork, and controls would be constructed adjacent to the modified valve house. Additional right-of-way would not be needed for the Outlet Power alternative.

Recreation

The plan includes expansion of the existing Lid Creek Campground by 17 units. Units would be overnight facilities able to accommodate recreation vehicles and tents. New facilities would include access roads, double and single spurs, loops, picnic tables, trash receptacles, tent pads, camp stoves, camp unit number posts, and a double-vault toilet. Right-of-way would not need to be acquired since the facilities will be located on Federal land.

Fish and Wildlife and Environmental Quality

The plan does not include specific fish and wildlife or environmental quality facilities. The reregulating dam is considered a power facility in in this analysis because some means of improving streamflows is considered essential to the acceptability of any power alternative.

Construction

The construction period is 4 years, the time period needed to construct the reregulating dam.

Construction costs, based on April 1979 price levels, total $36,895,000.

Operation and Maintenance

Operation of power facilities and the reservoir would not change from the existing operations at Hungry Horse Project. Decisions related to hourly and day-to-day operation of generators would continue to be made by the BPA control center in Vancouver, Washington. Powerplant operators at the Hungry Horse Project would continue to operate the powerplant in accordance with those decisions and Water and Power guidelines. Operation of the reregulating dam would be controlled by the powerplant operators under guidelines to be developed in cooperation with fish and wildlife agencies during advance studies.

Annual operation, maintenance, and replacement costs are estimated at $185,030.

The Lid Creek Campground, which is located in the Flathead National Forest, would continue to be operated by the Forest Service.

Economic and Financial Analysis

Based on preliminary evaluations, the Outlet Power plan is economically justified and financially feasible. Financial feasibility is based on the assumption that all costs are specific to either power or recreation. Power costs are reimbursable and would be repaid within a 50-year period. A reallocation of the Hungry Horse Project would be necessary in any detailed study to determine if part of the reregulating dam costs are joint costs to be allocated between power and fish and wildlife functions or assigned to an environmental quality objective.

Economic Justification

Economic justification is based on a comparison of direct benefits to costs over a 100-year period using a Federal discount rate of 7-1/8 percent and April 1979 price levels.

Benefits.--Annual equivalent benefits are estimated at $6,027,100. Power benefits of $5,711,800 reflect the cost of the most likely and comparable alternative (thermal generation) needed to produce the same amount of capacity and energy and also reflect a reallocation of existing energy production from less valuable energy to the more valuable peaking energy with the project. This reallocation results from the increased peaking capacity. After the net energy benefit was calculated, 15 percent was added to account for the anticipated increases in fuel costs beyond the general inflation rate because of scarcity, resource depletion, increased demand, and other factors.

Fishery benefits of $305,600 accrue from improved streamflow regime provided by the reregulating dam and reservoir. This benefit reflects an average increase in kokanee fish productivity and increased fisherman satisfaction based on a mathematical average of poor year and good year fish production anticipated with the plan.

Recreation benefits of $9,700 accrue from increased recreation opportunities provided by the Lid Creek Campground expansion. The benefit reflects an estimated annual increase of 4,444 visitor-days valued at $3.00 per day.

A summary of the monetary benefits is presented in table 6-4. Nonmonetary environmental and social benefits would also accrue to the plan, and these benefits are summarized in the four-account display.

Table 6-4.--Annual Equivalent Benefits of the Outlet Power Plan

Source	Outlet Power
Power	$5,711,800
Fishery	305,600
Recreation	9,700
Total	$6,027,100

Costs.--The net Federal investment for development of the Outlet Power plan is $41,027,000. This investment includes the cost of constructing all project facilities and interest during construction. Specific costs for archeological salvage and protection were not developed because powerplant estimates are assumed to include a sufficient allowance for any such costs that may be necessary. The Federal investment does not include investigation costs expended to date, which are normally deducted for benefit-cost comparison. Interest during construction is based on 7-1/8 percent during a 4-year construction period.

Annual costs of operation, maintenance, and replacement are estimated at $185,030.

The annual equivalent project cost for use in comparing costs to benefits on an annual basis is $3,111,030.

The derivation of the Federal investment costs and the annual equivalent project costs is shown in table 6-5.

Table 6-5.--Federal Investment and Total Annual Equivalent Costs of the Outlet Power Plan

Item	Outlet Power
Construction costs	
Reregulating dam1/	$ 5,600,000
Powerplant, switchyard, and related facilities	31,200,000
Recreation facilities	95,000
Total construction cost	$36,895,000
Interest during construction	
Reregulating dam1/	$ 798,000
Other facilities	3,334,000
Total interest during construction	$ 4,132,000
Federal investment	$41,027,000
Annual costs (100 years @ 7-1/8 percent)	
Annual equivalent Federal investment	$ 2,926,000
Operating costs	
Reregulating dam1/	10,600
Power	173,000
Recreation	1,430
Total operating costs	$ 185,030
Total annual costs	$ 3,111,030

1/ *The reregulating dam is considered a power facility for this study; however, costs associated with constructing and operating the reregulating dam have been separated out for greater clarification.*

Benefit-cost Ratio.--The benefit-cost ratio for the Outlet Power plan is 1.94 to 1.00 based on a comparison of annual equivalent benefits of $6,027,100 to the total annual project cost of $3,111,030. The economic rate of return1/ is 13-1/8 percent.

A summary of benefits and costs data is provided in table 6-6.

Table 6-6.--Benefit-cost Summary
(100 Years @ 7-1/8 Percent)

Item	Outlet Power
Annual equivalent benefits	$6,027,100
Annual project costs	3,111,030
Net benefits	$2,916,070
Benefit-cost ratio	1.94 to 1.00
Economic rate of return	13-1/8 percent

Comparability Test.--A comparability test was applied to the power function. The purpose of this test is to assure that a more economical means, evaluated in a manner comparable to the alternative, does not exist for accomplishing the power objective. For this analysis the separable cost of the power facilities of the Outlet Power plan was compared with the cost of a single-purpose federally financed thermal powerplant capable of producing energy equivalent to the alternative. The plan met the comparability test, i.e., the separable power cost of the plan was less than the cost of a comparable single-purpose thermal powerplant.

Cost Allocation

Since all costs are specific to power and recreation, a detailed allocation of costs of the plan was not made for this study. Costs were assigned to either power or recreation.

The cost of the reregulating dam is assigned to power in this analysis. Since the reregulating dam results in fish enhancement as well as fish conservation, the allocation of this cost would be reexamined at the feasibility level.

The cost of the existing Hungry Horse Project is allocated to the functions of power and flood control. As of September 30, 1979, the allocation of total construction costs to date was 76 percent to power and 24 percent to flood control.

1/ *The economic rate of return is the yield on the Federal investment. More precisely defined, the economic rate of return is the interest rate at which the benefit-cost ratio equals 1.0.*

The assignment of costs of the Outlet Power plan in this study is shown in table 6-7.

Table 6-7.--Summary of Cost Assignment

Costs	Outlet Power
	dollars
Construction	
Power	
Reregulating dam	5,600,000
Power facilities	31,200,000
Total	36,800,000
Recreation	95,000
Total construction	36,895,000
Operation	
Power	
Reregulating dam	10,600
Power facilities	173,000
Total	183,600
Recreation (at full development)	1,980
Total operation	185,580

Repayment and Financial Feasibility

Repayment requirements by function were estimated based on the specific cost of the features. The costs for features added by the plan were assumed to be specific costs for either power or recreation.

Power.--Any power additions at the Hungry Horse Project would be integrated into the Federal Columbia River Power System, and all power would be marketed by the BPA. All construction costs allocated to commercial power, along with interest during construction, are reimbursable with interest on the unpaid balance at the rate that is applicable in the year construction is begun. The interest rate in effect for fiscal year 1980 is 8.0 percent. The repayment period for commercial power extends 50 years from the first year of commercial service. The power repayment rate is determined by the average yield during the preceding fiscal year of marketable United States securities which have terms of 15 or more years remaining to maturity. All allocated operation, maintenance, and replacement costs are also paid by power revenues. Table 6-8 shows the annual financial requirement to repay the power cost in a 50-year period at 8.0 percent interest.

Table 6-8.--Financial Repayment Required to Repay Power Cost in a 50-year Period at 8.0 Percent Interest and Cost per Kilowatt Installed Capacity for the Outlet Power Plan

Item	Outlet Power
Annual financial requirement	
Investment	$3,387,200
Annual operation, maintenance, and replacement	183,600
Total annual requirement	$3,570,800
Annual financial requirement per kilowatt-hour (mills)	41.2
Construction cost per kilowatt installed capacity	$ 669

Fish and Wildlife.--Fishery enhancement of the Flathead River-Lake system results from flow regulation provided by the reregulating dam. In this analysis the reregulating dam costs were assigned to power because of the formulation criteria. That criteria states that the fishery should be at least maintained with any alternative power development. In that context, the reregulating dam would be a necessary requirement for any increased power production, and none of the costs of the dam were assigned to fishery enhancement.

Recreation.--Recreation costs accrue from expansion of an existing facility located on federally owned and operated land (Flathead National Forest). Recreation costs amounting to $95,000 for construction and $1,980 for annual operation, maintenance, and replacement would be nonreimbursable under the Federal Water Projects Recreation Act (Public Law 89-72).

Cost and Repayment Summary

Costs and repayment are summarized in table 6-9.

Table 6-9.--Cost and Repayment Summary

Item	Total	Reimbursable	Nonreimbursable
Power			
Reregulating dam	$ 5,600,000	$ 5,600,000	$ 0
Other	31,200,000	31,200,000	0
Total power	$36,800,000	$36,800,000	$ 0
Recreation	$ 95,000	$ 0	$95,000
Fish and wildlife	$ 0 1/	$ 0	$ 0
Total construction	$36,895,000	$36,800,000	$95,000
Interest during construction	$ 4,639,000	$ 4,639,000	$ 0

1/ *Full cost of reregulating dam assigned to power*

EVALUATION

Impacts or development effects of the Outlet Power plan were analyzed in four accounts. The four accounts are national economic development, regional development, environmental quality, and social well-being. The account displays are shown at the end of this chapter, and each account is summarized below.

National Economic Development

The major portion of economic benefits that would result from implementation of the plan is associated with power generation. Net annual benefits to the Nation with implementation of the Outlet Power plan would be $2,916,070.

Environmental Quality

Plan implementation would have both positive and negative effects on the environmental quality of the area. The fishery and other aquatic resources and the ecological systems of the Flathead River would benefit from implementation. In general, negative effects of plan implementation would not be significant since such effects would be limited to the relatively small reregulating reservoir area (88 acres).

Regional Development

Plan implementation would result in net monetary benefits to Flathead County of $1,992,800. Net employment gains for Flathead County would be 205 short-term jobs and 3 long-term jobs. The alternative would not have a significant effect on population changes and would have a slight beneficial effect on the county, region, and Nation through meeting more of the power needs. Since all power produced by the alternative would be marketed by BPA, BPA would be enabled to better supply its customer needs in the Flathead basin and other parts of western Montana as well as the rest of the BPA service area.

Social Well-being

Although implementation of the plan would have positive and negative social effects, most effects would be relatively minor. In contrast, improvement in the fishery would have a major effect, leading to increased satisfaction of both local and nonlocal fishermen. The aggregate social effect would be relatively minor but would be beneficial.

Table 6-10.--National Economic Development Account

Component	Outlet Power
Beneficial effects1/2/	
Direct user benefits	
Power	$5,711,800
Fish and wildlife	305,600
Recreation	9,700
Total	$6,027,100
Adverse effects (costs)1/	
Project costs--Hungry Horse	
Investment (construction and interest during construction)	$2,469,700
Operation, maintenance, and replacement	174,430
Subtotal	$2,644,130
Project costs--reregulating dam	
Investment (construction and interest during construction)	$ 456,300
Operation, maintenance, and replacement	10,600
Subtotal	$ 466,900
Total	$3,111,030
Net project benefits1/	$2,916,070
Benefit-cost ratio	1.94
Economic rate of return3/	13-1/8 percent

1/ *Annual equivalent values for 100 years at 7-1/8 percent interest*
2/ *External economies and employment of unemployed resources not identified for this NED analysis*
3/ *Interest rate at which the resulting benefit-cost ratio would be equal to 1*

Table 6-11.--Environmental Quality Account[1/]

Environmental Category	Remarks	Effect of Plan[2/] Outlet Power	No Action[3/]
Ecological components			
Biological resources			
Flora	Up to 45 acres of coniferous forest would be eliminated in the reregulating reservoir.	-3	0
Fauna			
Fishery	A low value kokanee and trout fishery will be eliminated after the reregulating dam is constructed. However, the main stem Flathead River and Flathead Lake kokanee fishery will be substantially improved when reregulating dam releases reduce riverflow fluctuations during fall-spring spawning and rearing periods. The future without fishery would decline from present "good years" for kokanee.	+10*	-7*
Aquatic insects	Insect populations will be reduced in the reregulating reservoir by severe pool fluctuations. Reduced substrate dewatering will significantly enhance aquatic insect production in the main stem Flathead River and increase the food base for fish populations.	+7*	0
Wildlife	Migration routes for deer and elk may be disrupted in the area of the reregulating dam. Reduced downstream flow fluctuations will benefit shore-dwelling species such as furbearers, waterfowl, and shorebirds. No net impacts from project are anticipated.	0	0
Ecological systems			
Forest	Up to 45 acres of coniferous forest would be eliminated in the reregulating reservoir.	-3	0
Flathead River	Reregulating dam will eliminate 3.4 miles of free-flowing river on the South Fork of the Flathead River. However, 46 miles of the main stem Flathead will have overall improvement in productivity of fish, aquatic insects, and wildlife due to beneficial flow modifications.	+7*	0
Estuarine and wetland areas	No impact	0	0
Wilderness, primitive, and natural areas	No impact	0	0
Physical components			
Water quality	Turbidity in the South Fork of the Flathead River will increase temporarily during construction of the reregulating dam. This turbidity will disipate and not be noticeable in the main stem Flathead River. Impact is considered negligible.	0	0
Air quality	There will be slight short-term impairment of local air quality during construction activities at the reregulating damsite and Hungry Horse Dam from heavy equipment exhaust emissions and dust.	-2	0
Land quality	No impact	0	0
Sound quality	Temporary increase in noise levels at construction sites. Impact is considered negligible.	0	0
Visual quality	Scenic quality of South Fork below Hungry Horse Dam may be reduced somewhat when 3.4 miles of free-flowing river is impounded by the reregulating dam.	-3	0
Geological resources	No impact	0	0
Cultural components			
Historical and archeological resources	A class I cultural resources survey shows no evidence of archeological or historic resources that would be impacted by the project. Any cultural resources found in reregulating reservoir area during advance planning would be mitigated.	0	0
Recreational components			
Open space and greenbelts	The reregulating reservoir may slightly detract from the open space setting along 3.4 miles of the South Fork Flathead River below Hungry Horse Dam. Impact considered slightly negative. No impacts farther downstream.	-3	0
Streams and stream systems	A low quality sport fishery will probably be eliminated in 3.4 miles of the South Fork Flathead River. However, future sport fishing will improve in both the main stem Flathead River and Flathead Lake as spawning conditions for kokanee improve. There will be a decline from present "good year" kokanee production under the No Action alternative.	+9*	-6*
Beaches and shores	Expansion of Lid Creek Campground will enhance shoreline recreation on Hungry Horse Reservoir. No impacts on the Flathead River-Lake system.	+1	0
Lakes and reservoirs	No impact	0	0

1/ The plan includes a minimum flow of 145 ft^3/s and a reregulating dam with 1,850 acre-feet of pool storage.
*2/ The maximum potential effects of the plan are +10 (very beneficial) and -10 (very adverse); significant effects are noted by an *. Values in the development plan column reflect anticipated differences from No Action alternative. Values in the No Action column reflect anticipated changes from current conditions.*
3/ No Action (future without development)--It is assumed that future peaking operations at Hungry Horse Dam will be more cyclic and structured than in the past. This will mean that both high and low flow durations will be reduced. As a result, Montana Department of Fish, Wildlife, and Parks biologists are expecting that kokanee salmon production will be below current "good years" (produced from high sustained flows) but above present "poor years" (from sustained low flows). Therefore, kokanee production success will be less erratic from one year to the next.

Table 6-12.--Regional Development Account

Monetary Impacts	Flathead County	BEA 153	Rest of Nation	NED
	dollars	*dollars*	*dollars*	*dollars*
Income effects				
Beneficial				
Value to users	669,300	2,447,600	2,910,200	6,027,100
External economies	0	0	0	0
Unemployed resources 1/	--	--	--	--
Increases from plan services 2/	0	94,400	-94,400	0
Construction and operation, maintenance, and replacement	1,341,300	252,600	-1,593,900	0
Subtotal	2,010,600	2,794,600	1,221,900	6,027,100
Adverse				
User payments	17,800	53,600	3,499,400	3,570,800
General taxes from rest of Nation	0	0	8,230	8,230
External diseconomies	0	0	0	0
Displaced resources	0	0	0	0
Loss in welfare payments 1/	--	--	--	--
Subtotal	17,800	53,600	3,507,630	3,579,030 3/
Total	1,992,800	2,741,000	-2,285,730	2,448,070

Nonmonetary Impacts	Flathead County	BEA 153	Rest of Nation
	jobs	*jobs*	*jobs*
Employment			
Beneficial effects			
Project construction	205	--	-205
Project operation and maintenance	3	0	-3
Indirect and induced	--	39	-39
Adverse effects	0	0	0
Net employment gains as a result of the project	208	39	-247
Duration of employment			
Short-term, full-time	40	52	-92
Short-term, seasonal	165	--	-165
Long-term, full-time	3	0	-3
Population effects	No significant population effects anticipated		
Economic base and stability			
Beneficial			
Stability of economic base	Project contributes to stability of the local impact area, region, and rest of Nation by helping to meet power needs and to strengthening of fishing-related businesses in the local area		

1/ *Not included in the NED and RD analysis for this level of study*
2/ *From fishery enhancement only*
3/ *Differs from NED account because of differences in repayment and formulation interest rates*

Table 6-13.--Social Well-being Account

Component	Impact	Effect of Plan[1/]
Area		
Power	The plan would reduce the 1990-91 average firm energy shortfall 2.6 percent.	+2
	Power imports to the Flathead basin would be reduced, and the area would be somewhat more likely to receive power under emergency conditions.	+1
Recreation	Fisherman success rates for kokanee would be improved considerably.	+4
	Additional camping facilities would be made available.	+1
	Kayaking on the South Fork would be curtailed.	-1
Economic base	Additional power would help support the existing base.	+1
	Private campground operators in the Hungry Horse area would be negatively impacted by the new camping facilities.	-1
Employment	Construction employment impacts: Construction period 4 years; Average number of jobs 205; Peak number of jobs 509	+2
	Approximately 80 percent of the jobs would be filled by people from the local area. About 30 percent of these jobs would be filled by unemployed or underemployed people.	+2
	The project would help support existing fishing-related jobs in the Flathead basin.	+2
Income	Larger cities in the region and communities near the dam would experience income increases during construction.	+2
	Direct and indirect income from the recreation and fishery aspects of the project would range between $133,000 and $159,000 per year and would accrue mostly to the Flathead Lake area.	+1
Transportation	There would be increased traffic on Highway 2 near the dam and on access roads to the dam during the construction period.	-2
Community		
Population	Population increases in communities near the dam would peak at 200 to 300.	-1
Education	Increases in enrollment would be minor. Classroom capacity would be adequate.	-1
Housing	Housing demand would increase during the construction period, and housing would be available.	+1
Law and justice	Some increase in cival and criminal code violations in the construction area would be likely.	-1
Attitudes	Changes that improve the fishery would be generally supported by people in the Flathead basin. Most residents favor increased power production.	+2
Individual		
Safety	The present minor safety hazard resulting from flow fluctuations below the dam would be considerably reduced with the addition of the reregulating dam.	+2
	Traffic hazards would be increased on Route 2 and dam acess roads during construction.	-2
Environment	Some air, water, and noise pollution would occur during construction.	-2
	Esthetics associated with 3.4 miles of free-flowing river would be affected by development of the reregulating reservoir.	-1
Family	Construction employment opportunities in the local area would increase family income and quality of life for those families impacted.	+2
Recreation	In poor water years the quality of the fishing experience would greatly improve in Flathead Lake and River.	+3
	The improved fishery would greatly benefit retired populations in the local area who make up a high percentage of kokanee snaggers.	+3
	Lake fisherman (most of whom are from outside the area) would have an increased likelihood of a high quality experience.	+2
	Camping experience would be improved slightly for both local users and Glacier National Park recreationists.	+1
Special groups	Additional power would contribute to easing the burden of rapidly increasing power costs on low and fixed income populations.	+1
National emergency preparedness		
Power supplies	Average energy production would increase slightly, and additional emergency capacity would be available.	+2
Scarce fuels	The plan would save the equivalent of 160,000 barrels of oil per year.	+2
Aggregate social effects		
Quality of life	Recreation experience would be enhanced for fishermen.	+2
	Additional power would contribute to maintenance of existing quality of life.	+1
Social well-being	Increased income from fishing would lead to slight improvements in income stability, services, and standard of living for the small communities around Flathead Lake.	+1

1/ Effects are rated on an 11-point scale ranging from very beneficial (+5) to very adverse (-5). Effects were rated by the regional sociologist and regional economist assigned to the project. Interrater reliability based on the first set of ratings was 0.89. Differences were discussed and a consensus achieved on the final ratings.

OTHER PLANS AND PLAN ELEMENTS

STRUCTURAL PLANS AND PLAN ELEMENTS

Several plans and planning elements in addition to the Outlet Power plan were considered or partially analyzed in the course of this investigation. These plans and plan elements fall into two broad categories: (1) partially evaluated and found to be unacceptable, not economically justified, or require evaluation at a level of detail beyond the scope of a preliminary study and (2) not evaluated but should be considered during any future study.

Plans or elements that fall into category (1) include the following:

1. Alternatives that include increasing the electrical capacity of the existing generators.

2. Alternatives identical to the Outlet Power and those included above but without inclusion of a reregulating dam.

3. A new 100,000- or 200,000-kilowatt powerplant to be located on the left bank of Hungry Horse Dam.

4. A 4,000-, 6,000-, or 8,000-kilowatt low head powerplant to be located at the reregulating dam included in the Outlet Power and other plans.

5. A multilevel outlet to replace the existing outlet of Hungry Horse Dam.

Planning elements that fall into category (2) include the following:

1. Removal of old car bodies now located along the main stem Flathead River and replacement with riprap.

2. Construction of a kokanee spawning channel just below the reregulating dam included in some alternatives.

3. Modification of Hungry Horse Project operating criteria.

4. Modernize and expand existing visitor facilities at the Hungry Horse Project.

5. Construct additional recreation facilities, other than the Lid Creek expansion, along Hungry Horse Reservoir.

Alternatives That Include Increasing the Electrical Capacity of the Existing Generators

The potential for increasing the electrical capacity of the existing generators exists because the present hydraulic capacity of the turbines and penstocks exceeds the electrical limits of the generators under normal

conditions. At a head of 398 feet (hydraulic capacity of 11,420 ft^3/s) electrical limits are met; however, above this head hydraulic capacity increases and flows must be restricted so that electrical limits are not exceeded.

Rewinding the existing generators to increase the nameplate capacity by 15 percent, an increase that has been made at some powerplants, was not evaluated for this study because the existing generators are capable of being run safely on a continuous basis at 15 percent above the nameplate rating.

With an uprate to a 385,000-kilowatt nameplate rating (35-percent increase), heads of 398 to 444 feet could be used to increase generating capability; a maximum flow rate of 12,060 ft^3/s would be possible and allowable. Based on historical flows and reservoir levels, such an uprate could produce additional peaking capability most of the time. Uprates beyond 385,000 kilowatts to as much as 430,000 kilowatts appear possible from a hydrologic standpoint. However, physical, technical, or economic constraints could lower maximum generator capability. Maximum generator capacity and plant sizing should be reviewed and studied during more detailed studies.

Two plans based on uprating the existing generators to 385,000-kilowatt nameplate capacity, the Uprate and Uprate Plus Outlet Power plans, were formulated and partially evaluated. These plans are identical to the Outlet Power plan with the following exceptions: (1) the Uprate plan includes uprating the existing powerplant to 385,000 kilowatts but does not include a 55,000-kilowatt powerplant at the outlet works and (2) the Uprate Plus Outlet Power plan includes the uprate and the 55,000-kilowatt powerplant. These two plans were not fully evaluated and compared with the Outlet Power plan because all of the costs for an uprate were not developed and do not reflect the total cost. The cost of replacing accessory electrical equipment was not developed in view of the time frame and study costs constraints at this preliminary stage of investigation.

Preliminary analysis of the Uprate and Uprate Plus Outlet Power plan effects on environmental quality, social well-being, and regional development would generally be beneficial. These two plans would be reviewed during more detailed studies.

Alternatives without a Reregulating Dam and Reservoir

Plans without a reregulating dam violate the formulation criteria and are unacceptable without the inclusion of some additional element that would reduce flow fluctuations or in some way maintain or enhance the present Flathead River-Lake fishery. For example, benefits and costs for an Outlet Power plan with and without reregulation were calculated to show the conflict between the power and fishery functions. Comparison of the plans also provides an indication of the true cost of the reregulating dam and reservoir as a means of maintaining or enhancing the existing fishery.

The power and recreation functions of the without reregulation plan would be identical to the with reregulation plan. However, fish production and fisherman satisfaction would be much less than exists at present. Although nonmonetary effects were not evaluated, environmental quality and social well-being would be reduced below present levels. A summary of economic analysis is presented in table 7-1 for comparison.

Table 7-1.--Economic Analysis Summary Comparing the Outlet Power Plan with and without Reregulation

Item	With Reregulating	Without Reregulating
Annual equivalent benefits	$6,027,100	$5,673,200
Annual equivalent costs	$3,111,030	$2,644,130
Benefit-cost ratio	1.94 to 1	2.14 to 1
Construction cost per kilowatt installed capacity	$ 669	$ 567
Annual requirement for repayment1/		
Total	$3,570,800	$3,029,200
Per kilowatt-hour (mills)	41.2	34.9

1/ *Annual payment required to pay power costs in a 50-year period at 8 percent interest*

100,000- and 200,000-Kilowatt Left Bank Powerplant

These potentials are based on boring a hole through the existing Hungry Horse Dam, installing new steel penstocks, and constructing an indoor powerplant on the left bank of the river below the dam. A 14-foot-diameter penstock for the 100,000-kilowatt powerplant or a 20-foot-diameter penstock for the 200,000-kilowatt powerplant would be installed in the existing dam. The powerplant would house three generating units of equal size (each driven by a Francis turbine) and having a total nameplate rating of 100,000 kilowatts or 200,000 kilowatts. Total discharge at a rated head of 398.0 feet would be 3,531 ft^3/s or 7,023 ft^3/s for the 100,000-kilowatt and 200,000-kilowatt powerplants, respectively. In addition to the indoor powerplant, a new switchyard including circuit breakers, switches, controls, and buswork would be required. The powerplant would be located on federally owned land, so no right-of-way would need to be acquired.

A total of four alternative plans based on these potentials were partially analyzed. Each plan included the recreation facilities described in the fully evaluated plans and a 100,000-kilowatt or 200,000-kilowatt left bank powerplant. The economics of these plans, two with and two without the reregulating dam described in the fully evaluated plans, were analyzed. Analysis without the inclusion of the reregulating dam was made to show economic trade-offs and because the small size of the reregulating dam compared to the large increase in discharge capability would permit very little flow regulation. Economic analysis was limited to the power and recreation functions because information was insufficient to analyze the possible effects on the fishery.

Economic analysis showed that each plan was economically justified; benefit-cost ratios range between 1.39 to 1.00 and 1.66 to 1.00. This analysis, however, does not account for probable negative economic effects on the fishery or problems that could be encountered in boring a hole in the dam.

Additional detailed information and further analysis would be necessary to conclude that these potentials are economically justified and to assess whether plans including such potentials would be acceptable from a fishery or environmental quality perspective.

Low Head Powerplant at the Reregulating Dam

The potential for adding a 4,000-kilowatt, 6,000-kilowatt, or 8,000-kilowatt powerplant at the reregulating dam included in some alternatives was analyzed on an incremental basis. The powerplant in each case would contain two equal-sized generating units turned by low head bulb turbines and would be located near the right abutment of the reregulating dam. Design flow for the 4,000-, 6,000-, and 8,000-kilowatt powerplants would be 1,800 ft^3/s, 2,700 ft^3/s, and 3,470 ft^3/s, repectively, at a rated head of about 32 feet. A new switchyard containing circuit breakers, switches, controls, and buswork would be needed in addition to the powerplant building.

Economic analysis indicates that none of the three powerplant sizes is economically justified at this time. This potential was dropped from further consideration, but costs and benefits would be reviewed during more detailed feasibility studies.

Multilevel Outlet Works

The potential for improving the temperature regime in the South Fork and main stem Flathead River by installation of a multilevel outlet works at Hungry Horse Dam is suggested in the Flathead River Basin Level B Study and was evaluated in this study. Present releases from Hungry Horse Dam remain near a constant 41° F throughout the year, reducing the productivity of aquatic insects in the South Fork and possibly reducing fish productivity in the main stem. The multilevel outlet was evaluated as one potential means of improving the downstream temperature regime.

Investigation of thermal stratification in Hungry Horse Reservoir revealed that virtually all seasonal changes in water temperature occur in the top 50 feet. Computer simulation studies of selective withdrawal indicate that a multilevel outlet at Hungry Horse Dam could significantly improve the downstream temperature regime. Water would have to be withdrawn from the top 50 feet of the reservoir.

Based on this finding, the Montana Department of Fish, Wildlife, and Parks has indicated that the loss of the reservoir fishery would outweigh any benefit that a multilevel outlet could provide for the downstream fishery. Further consideration of a multilevel outlet at Hungry Horse Dam does not appear justified unless fishery studies now in progress can demonstrate a definite need. If a need is demonstrated, this problem would be addressed in greater depth during more detailed feasibility studies.

Removal of Old Car Bodies

Numerous junked car bodies were at one time placed in the main stem to control bank erosion. The car bodies originally provided good fish habitat. However, many of the car bodies no longer serve any function because of poor placement, movement by streamflows, changes in channel configuration, and silt buildup. The car bodies are now a navigation hazard and are esthetically unpleasing.

Replacement of the junked cars with suitable rock riprap would provide more effective erosion control, permanently improve fish habitat, and improve the visual quality. In addition, the navigation hazard would be eliminated.

This potential was identified but not evaluated during the appraisal study. Evaluation of the potential should be included in any future planning effort.

Kokanee Spawning Channel

At present, spawning habitat for kokanee in the South Fork Flathead River is limited by suitable substrate and extreme flow fluctuations. A potential exists for increasing fishery productivity by constructing a kokanee spawning channel downstream from the reregulating dam included in some of the alternatives. The bottom of the channel would be lined with suitable-sized gravel, and a controlled portion of the riverflows would be diverted through the channel.

Although the potential for a kokanee spawning channel in the South Fork was not evaluated in this study, artificially constructed kokanee channels have been successful on other streams. Evaluation of this potential should be included in future detailed studies.

Modification of Hungry Horse Operating Criteria

Changing operating criteria at the Hungry Horse Project is a potential alternative to constructing a reregulating dam for flow control purposes. Modifications that could benefit the fishery include limiting flow fluctuations and lowering maximum flows during critical spawning periods and increasing minimum flows during egg incubation periods.

Any change in the operating criteria at Hungry Horse Dam would impact the Federal Columbia River Power System. Evaluating this impact would generally require detailed studies beyond the scope of a preliminary study. Future detailed studies should include an evaluation of the potential for modifying Hungry Horse Project operating criteria.

Hungry Horse Visitor Facilities

The existing visitor facilities at the Hungry Horse Project may be inadequate and are becoming dated. The potential for modernizing the existing facilities and providing additional interpretive facilities at the powerplant or elsewhere on the project should be evaluated in any future planning effort.

Recreation Facilities Along Hungry Horse Reservoir

In addition to expansion of the existing Lid Creek Campground, several potential development sites along Hungry Horse Reservoir were identified. Present information is not adequate to assess whether development of such facilities is needed. These potentials should be addressed during future detailed studies.

NONSTRUCTURAL AND WATER CONSERVATION ALTERNATIVES

Nonstructural alternatives were not addressed in this investigation because secondary information is generally not available and developing the information needed would require detail not appropriate at a preliminary level of study. The BPA has a study underway to identify and evaluate some types of nonstructural alternatives to power development in the Pacific Northwest. Study results should be available in the near future and would be included in a more detailed study of the opportunities at the Hungry Horse Project. At this time, both conservation and new generation sources appear to be needed if projected powerloads are to be met.

Since the authorized purposes of the Hungry Horse Project and the opportunities identified in this investigation are related primarily to nonconsumptive water use, water conservation alternatives were not identified. Any identifiable water conservation opportunities would probably be related to nonstructural power alternatives and would be identified in more advanced studies.

PLANNING CRITERIA AND STANDARDS

In accordance with the preliminary nature of the investigation, the near term (to the year 2000) is the time frame used in projecting future problems and needs and formulating alternative plans to meet those needs. Costs, benefits, and other data used or developed in the study are appraisal level, intended to have sufficient accuracy and detail to assess whether the identified potentials have sufficient merit to warrant detailed planning which could lead to congressional authorization for construction. Sufficient detail and accuracy for more rigorous purposes was not intended or developed.

Potential plan elements were identified and analyzed for benefits, costs, and accomplishment of study objectives. Plan elements that favorably passed this analysis were incorporated into a plan.

The Water and Power Resources Service planning team consisted of members with expertise in several fields including hydrology, water quality, wildlife biology, engineering, economics, and sociology. Through the course of the investigation the team contacted members of various local, state, and Federal agencies and entities. Close coordination was maintained with the Montana Department of Fish, Wildlife, and Parks and the U.S. Fish and Wildlife Service since present operation of Hungry Horse Powerplant and any future changes or additions have direct relationship to the kokanee fishery of the Flathead Lake-River system. The various contacts assisted the team in identifying problems and needs, planning constraints, and in formulating and evaluating plans.

Throughout the planning effort a variety of criteria and standards were used in plan formulation and evaluation. These criteria and standards are derived from a variety of laws, rules, and regulations. Economic criteria and standards are generally the same as those used in analyzing potential plan impacts. This chapter outlines the criteria and standards used in the formulation process and summarizes the constraints identified and adopted during the formulation process.

STUDY AREA BOUNDARIES

The study area can be generally defined as the existing Hungry Horse Project and South Fork downstream to the confluence with the main stem Flathead River. A single specific geographic boundary is not appropriate for all functions considered or study phases.

Problems and Needs Identification

Boundaries of influence were selected for various types of problems and needs as follows:

Problem and Need Category	Geographic Unit
Power	Flathead River basin, Pacific Northwest
Fish and wildlife, environmental quality	Flathead River-Lake system and adjacent lands in Flathead County
Recreation, social, economic	Flathead County
Flood control, municipal and industrial water supply, irrigation	Flathead River basin

Resource Capability

Resource inventory and assessment of capability was based on the resources available in the Flathead River basin.

Development

The site of development was limited to the existing Hungry Horse Project and a short stretch of the South Fork Flathead River below Hungry Horse Dam. This area was originally selected as having the highest potential for development, but the area of development could have been increased if appropriate. The assessment of resource capability indicated that an expansion of the development area was not needed.

Analysis of Potential Impacts

Boundaries for analysis of potential impacts of the alternative plans and potential plan elements was limited to the areas listed under "Problems and Needs Identification."

POWERPLANT SIZING

Powerplant sizing is based on a 39-year period (1929-67) of flow data. System monthly operation studies were made using the Hydro System Seasonal Regulation computer program. This program simulates the Pacific Northwest hydroelectric system operation as it exists under present agreement procedures and regulations. Historical flows were modified to reflect irrigation and industrial depletions. Projections of electrical loads and generation capability, including thermal, for the year 2000 were used in the program.

Peaking studies are based on the assumption that hydropower in the future will account for more of the peak generation and less of the baseload generation in the Pacific Northwest. Peaking operations of 8 hours for 5 days of the week were assumed for future Hungry Horse Powerplant operation.

Dependable capacity and energy production of each alternative was assessed through the hydrologic studies. Dependable capacity is the maximum generating level that a plant can meet under adverse streamflow conditions. For this study the 42-1/2-month period (mid-August 1928 through February 1932) of low flows was the basis for assessing dependable capacity.

Energy production was evaluated from simulated peaking operation studies which identified (1) energy at peak by month and (2) total energy production. Both peak energy and nonpeak energy were identified for each alternative because the monetary benefit of peak energy is much greater than baseload or other nonpeak energy.

BENEFITS

Appraisal level benefits, developed to evaluate plan elements and alternative plans, consisted of values to direct users from the increased output of goods and services. Indirect benefits that accrue from increased economic efficiency or the employment of unemployed labor resources were not developed because of either the lack of generally acceptable measurement techniques or the benefits are incidental to economic justification of the alternatives.

Power

Hydroelectric power benefits were estimated by developing power yields through hydrologic studies and applying the cost of electric power from the most comparable alternative. A thermal alternative is the most likely type available in the area, and costs reflect the type of financing that would be made if such a plant were constructed. Power values were developed in two components--capacity and energy. The capacity component is related to fixed plant costs, and the energy component reflects the variable plant costs such as fuel, operation, and maintenance.

The Federal Energy Regulatory Commission (FERC) provided January 1978 cost level values for the alternative thermal plants. The FERC values are based on 25-percent private financing at 10 percent interest and 75-percent public non-Federal financing at 6.0 percent interest. These values were indexed to 1979 cost levels because more current cost level data was not available from FERC. Capacity values were indexed by using the Handy Whitman Index, and energy values were indexed by using the price index of middle distillate fuel oil and coal provided by the U.S. Department of Commerce (Survey of Current Business). A real fuel cost escalation component amounting to 15 percent of the net energy benefit was included in the estimate of power benefits. Power values were adjusted from the at-market to the at-site value to be comparable with cost estimates, which are at-site values.

Fish and Wildlife

Fishery benefits were estimated by the Montana Department of Fish, Wildlife, and Parks using fisherman satisfaction units (FSU). This unit is a value judgment as to the relative worth a fisherman places on catching a fish. Values of 1 to 10 were assigned to various sport fish depending primarily on species and length. As an example, a value of 10 was assigned to bull trout larger than 24 inches, while a value of 2 was placed on lake-caught kokanee, and a value of 1.5 was placed on river or spawning kokanee. Aggregate FSU are a measure of both quality and quantity of the fishing experience. A monetary value of $0.7609 per FSU was furnished by the Montana Department of Fish, Wildlife, and Parks. Conversion of FSU to fisherman-days was not considered necessary to the study or appropriate to the report. However, the U.S. Fish and Wildlife Service supplied conversion information (15.1 FSU per fisherman-day) to determine whether the monetary values were in accordance with other standards. The monetary value of FSU, equivalent to $11.49 per fisherman-day, is in accordance with the values contained in the Water Resources Council Principles and Standards for Planning Water and Related Land Resources.

Recreation

Visitor usage was estimated by the Water and Power Resources Service. Value associated with increased use is estimated at $3.00 per recreation-day, which is in accordance with the values used in the Water Resources Council Principles and Standards for Planning Water and Related Land Resources.

COSTS

Appraisal level costs were developed for potential plan elements and alternative plans based on April 1979 price levels. Costs are of two types: (1) investment cost, which includes construction and interest during construction and (2) operation, maintenance, and repair costs. Cost estimates do not include investigation costs expended to date.

Investment Costs

Appraisal level cost estimates are based on Appendix A estimating data, curves, and other data developed by the Water and Power Resources Service, Engineering and Research Center. Quantities were developed from general layouts and low head powerplant curves developed by Tudor Engineering Company. Field costs include 25 percent for contingencies. Overhead items were estimated from the Water and Power's Estimating Curves for Indirect Costs. All estimates were indexed to April 1979 price levels.

Interest during construction was computed using a short method, rather than estimating expenditures by year.

Annual Costs

Annual operation and maintenance costs were developed from estimating curves contained in Water and Power Instructions. Operation and maintenance of power features are assumed to be handled as facilities of the Hungry Horse Project. Costs associated with the reregulating reservoir and dam are based on the additional labor and material costs of operation and maintenance crew at Hungry Horse. Costs for rewind of existing generators are based on the incremental cost of operation and maintenance.

Annual operation and maintenance costs of recreation facilities are estimated at $0.40 per user-day.

Interest Rates

The interest rate used for computing interest during construction, amortizing the Federal investment, and determining annual equivalent benefits and costs over the period of analysis is 7-1/8 percent, the rate in effect for fiscal year 1980. This rate is specified by the Water Resources Council in accordance with the Water Resources Development Act of 1974 (Public Law 93-251).

The interest rate used in the estimate of power repayment capability is 8.0 percent, the rate in effect for fiscal year 1980.

Period of Analysis

A 100-year period of project costs and benefits is used to assess economic justification. The basic structure, Hungry Horse Dam, was completed in 1953. The integrity of the structure along with sufficient annual maintenance and replacement will assure a 100-year life expectancy.

Benefit-cost Comparison

Benefits and costs were converted to annual equivalent values for the 100-year period of analysis using an interest rate of 7-1/8 percent. Net benefits and benefit-cost ratios were calculated.

Comparability Test

A comparability test for power was made to assess whether a more economical means of accomplishing the same purpose existed. The normal comparison is the separable costs of the potential powerplant addition with the cost of producing the same power at an alternative single-purpose federally financed thermal powerplant. Total cost of powerplant additions was used for the test in this study.

Economic Rate of Return

An economic rate of return was estimated for each alternative. This rate is the interest rate at which the benefit-cost ratio is 1.0 or the rate at which the present worth of the stream of benefits equals the present value of the stream of costs. The economic rate of return is essentially the yield on the Federal investment.

Cost Allocation

An allocation of costs to components or purposes of a project is normally made and required by existing laws and associated policies. Allocated costs provide the basis for assessing financial feasibility and estimating repayment.

All costs associated with the alternatives developed in this study are intended to enhance power and conserve or enhance fish and wildlife and recreation. For the purposes of this study all costs are specific to power and recreation. Costs of the reregulating dam were assigned to power because a reregulating dam is assumed necessary for acceptability of additional power development.

If determined appropriate, a reallocation during more advanced studies (probably during the preparation of a definite plan) would recognize any changes in project beneficiaries in addition to any additional share of joint costs associated with the existing dam and reservoir that should be allocated to power, fish and wildlife, recreation, and possibly environmental quality.

Financial Feasibility and Repayment

Repayment studies are prepared to evaluate whether reimbursable project costs can be repaid in accordance with existing laws and policy. All or a portion of the costs allocated to the national economic development components of power, fish and wildlife, and recreation are reimbursable. Costs related to environmental quality (except for water quality to meet state standards) and cultural resource activities are nonreimbursable. Costs associated with preauthorization investigations are nonreimbursable.

Repayment criteria for power and recreation, the only functions assigned costs in this study, are given below.

Power

All construction costs allocated to commercial power along with interest during construction are reimbursable with interest on the unpaid balance at the rate of 8.0 percent, the rate in effect for fiscal year 1980. The power repayment rate is established in Secretarial Order 2929 and developed in the Interior Department Manual. The manual provides that the interest rate for Federal power projects will be determined by the average yield during the preceding fiscal year of marketable United States securites which have terms of 15 or more years remaining to maturity. All allocated operation, maintenance, and replacement costs are also reimbursable. The repayment period for commercial power extends 50 years from the first year of commercial service.

Recreation

Cost-sharing policy for recreation is also covered by the Federal Water Project Recreation Act of 1965 as amended by the Water Resource Development Act of 1974.

Recreation costs identified in the alternative plans would be nonreimbursable because the facilities would be located within a national forest and administered by the Forest Service. The Forest Service would provide annual operation and maintenance.

ENVIRONMENTAL QUALITY ASSESSMENT

Information for the assessment was gathered by studying available literature pertinent to the setting, observation, and coordination with the Montana Department of Fish, Wildlife, and Parks and the U.S. Fish and Wildlife Service. Data were subjectively analyzed with the goal of developing plans that would maintain or enhance the natural quality. In addition, the Water and Power Resources Service contracted with the Montana Department of Fish, Wildlife, and Parks for a 3-year study of the upper Flathead River system. Information from this study, which is as yet incomplete, was used as it was made available.

REGIONAL DEVELOPMENT ASSESSMENT

Procedures and standards from the Water and Power Instructions, Series 110, Part 116, were used to evaluate regional development effects.

SOCIAL ASSESSMENT

Procedures and standards from the Water and Power Instructions, Series 110, Part 118, were used to evaluate social factors. Procedures were adjusted to a general level appropriate to an appraisal study.

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